



US Army Corps
of Engineers
Sacramento District

Reconnaissance Report

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AMERICAN RIVER WATERSHED INVESTIGATION, CALIFORNIA

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January 1988



89002294

RECONNAISSANCE REPORT
AMERICAN RIVER WATERSHED INVESTIGATION, CALIFORNIA

JANUARY 1988

Department of the Army
Sacramento District, Corps of Engineers
Sacramento, California

RECONNAISSANCE REPORT
AMERICAN RIVER WATERSHED INVESTIGATION, CALIFORNIA

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SYLLABUS

This reconnaissance report has been prepared by the Sacramento District Corps of Engineers in accordance with the 1987 Appropriations Act. The report describes studies of alternative measures for flood control in the American River Watershed predicated on the assumption that Auburn Dam as previously authorized will not be constructed. Studies have focused on (1) definition of flood problems in the watershed, (2) formulation and evaluation of alternative plans for detailed development in future feasibility studies, (3) development of a management plan for the feasibility studies, and (4) identification of a non-federal sponsor for the feasibility study.

The primary study area included the lower American River between Nimbus Dam and the Sacramento River and the Natomas area and vicinity of Sacramento. Other areas considered were the American River and its tributaries upstream from Nimbus Dam, Sacramento River from the American River upstream to the Sacramento Weir, and Yolo Bypass and its immediate tributaries and distributaries. Major flood control facilities and features in the study area are 400,000 acre-feet (ac-ft) of seasonally dedicated space in Folsom Reservoir, located about 25 miles east of Sacramento, and a complex system of levee and channel improvements downstream along the American and Sacramento Rivers and in the Yolo Bypass.

In February 1986, major storms in northern California caused record floodflows in the American River Basin. Prior to this time, it was believed that Folsom Dam and Reservoir could control flows along the lower river to 115,000 cubic feet per second (cfs) for events having return periods of about once in 120 years, on the average. However, recent studies of Folsom Reservoir flood operation and flow-frequency relationships have shown that the facility is capable of controlling only about the 63-year flood to 115,000 cfs. The outflows from Folsom Dam capable of causing major flood damages along the river are expected to occur significantly more often than previously believed. It is estimated that nearly 350,000 people live in the area subject to flooding either caused or affected by flows on the American River.

Primary measures identified in this report to reduce the flood threat include:

- Mainstem American River
 - o Increased flood control storage space in Folsom Reservoir.
 - o Increased Folsom objective outflows (i.e., increase downstream levee and channel flood carrying capacity).
 - o Construct new flood control storage upstream from Folsom Reservoir.
 - o Perform structural modification of Folsom Dam.
 - o Construct offstream storage (or out-of-basin diversions).

- o Construct levee improvement in and around the Natomas area.
- o Construct channel improvement in the Natomas East Main Drainage Canal and Natomas Cross Canal.
- o Construct reservoirs upstream from Natomas.

Of the many potential combinations of the above measures, several of the most practical were formulated into alternative plans to provide specific levels of flood protection. They are as follows:

- Mainstem American River
 - o 100-year flood protection
 - * Increase Folsom objective release from 115,000 cfs to 180,000 cfs; i.e., construct levee and channel modifications to accommodate the higher objective release along American River and pertinent tributaries and distributaries.
 - * Increase Folsom flood control storage from 400,000 ac-ft to 630,000 ac-ft and objective release to 130,000 cfs; i.e., construct levee and channel modifications.
 - * Increase Folsom flood control storage to 650,000 ac-ft, lower the existing spillway, and maintain current objective release of 115,000 cfs.
 - o 150-year flood protection
 - * Increase Folsom flood control storage to 620,000 ac-ft, lower the existing spillway, and increase objective release to 180,000 ac-ft; i.e., construct levee and channel modifications.
 - * Construct a dam and 420,000 ac-ft single-purpose reservoir at or near the existing Auburn Dam site.
 - o 200-year flood protection
 - * Construct either a single-purpose dam and reservoir (570,000 ac-ft minimum) or create space for flood control in a new multiple-purpose reservoir at or near the Auburn Dam site.
- Natomas area (100- or 200-year levels of flood protection)
 - o Construct a gated/pump structure at the mouth of the Natomas Cross Canal and channel and levee improvements around the Natomas area, upstream along Arcade and Dry Creeks, and at selected other locations.
 - o Construct levees across the Natomas area along several alternative alignments and levee and channel improvements similar to the above.
- Mainstem American River and Natomas area
 - o Construct combinations of the above alternatives for various levels of flood protection.

Major economic benefits, costs, and environmental impacts of the alternatives were identified. A comparison of the alternatives indicated the following:

- Along mainstem American River, 100- to about 150-year levels of flood protection can be economically achieved through

modifications to Folsom Dam and downstream levees and channels.

- Levels of protection along the river in excess of 150 years can be economically achieved by constructing new storage upstream from Folsom Reservoir.
- Either all or part of the Natomas areas can be protected by economically feasible alternatives for various levels of flood protection for about the same cost.
- Along American River, net economic benefits would likely be maximized with projects providing a higher level of flood protection, whereas in the Natomas area it is not obvious at this time what level of flood protection would maximize net benefits.
- There are significant savings in costs if solutions to the flood problems in both areas are constructed as part of the same project.

This report recognizes that the Auburn Dam project is currently authorized for construction by the U.S. Bureau of Reclamation. It also recognizes that further efforts by the Corps of Engineers regarding flood control along mainstem American River will be consistent with language in the Fiscal Year 1988 Continuing Resolutions Act.

From the alternatives identified and coordinated with the potential non-Federal study sponsor, several candidate plans were identified. These plans will be emphasized in future feasibility studies. Each plan would provide a minimum 200-year level of protection. Along American River, the plans include constructing new flood control storage upstream from Folsom. In Natomas, the candidate plans include protecting all or part of the area either by constructing new levees, modifying levees, or providing related facilities.

The State of California is expected to act as the non-Federal sponsor for feasibility studies and to share equally in the costs for the studies with the Federal Government. The State anticipates financial participation in the feasibility studies by Counties of Sacramento, Sutter, Placer, and El Dorado; City of Sacramento; and Reclamation District 1000.

A number of study conclusions are presented. Three primary conclusions are that (1) there are serious flood problems in the Sacramento area, (2) there are economically feasible solutions to resolve these problems, and (3) the requirements for completion of the reconnaissance phase have been fulfilled. A recommendation is made that feasibility studies proceed for mainstem American River and Natomas area.

RECONNAISSANCE REPORT
AMERICAN RIVER WATERSHED INVESTIGATION, CALIFORNIA

I. INTRODUCTION

A. Study Authority. -- This study was conducted under the authority of the Flood Control Act of 1962 (Public Law 87-874, dated October 23, 1962) as follows:

"The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to wind or tidal effects, to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its territorial possessions, which include the following named localities: Sacramento River Basin and streams in northern California draining into the Pacific Ocean for the purposes of developing, where feasible, multi-purpose water resource projects, particularly those which would be eligible under the provisions of title III of Public Law 85-5001."

In addition, the 1987 Appropriations Act directed the Corps to "engage in a one-year reconnaissance study of alternative means of flood control in the American River, California, watershed predicated on the assumption that an Auburn Dam as previously authorized will not be constructed."

B. Purpose and Scope. -- The purpose of this report is to present the results of the reconnaissance study. The reconnaissance study is to accomplish the following:

- Define flood problems and opportunities, and identify potential solutions.
- Determine whether planning should proceed further, into a feasibility phase, based on a preliminary appraisal of the Federal interest, cost, benefits, and environmental impacts of the identified potential solutions.
- Estimate the time and costs for the feasibility phase.

- Assess the level of interest and support of non-Federal interests in the identified potential solutions.

C. **Prior Studies and Reports.** - Numerous studies and reports have provided useful information to this study. Several are discussed below.

1. **Corps of Engineers, Sacramento District.** - In March 1987, a report entitled "Special Study on the Lower American River, California" was prepared for the U.S. Bureau of Reclamation, Mid-Pacific Region (USBR) and the California Department of Water Resources (DWR). The study provided the USBR and the DWR with updated information on flood problems and possible solutions along the American River and with flood control benefits.

2. **U.S. Bureau of Reclamation.** - The USBR has prepared numerous reports related to water resources development in the American River Basin. Most of the studies focused on developing the Auburn Dam project and other features of the Auburn-Folsom South Unit of the Central Valley Project (CVP). The most recent report, entitled "Auburn Dam Report - Auburn Dam Alternative Study," was prepared for the members of a State/Federal Auburn Dam Task Force in July 1987. The report analyzed costs associated with five alternative reservoir sizes at the Auburn damsite. The report was prepared to provide the Secretary of the Interior and local leaders with enough information to determine the merit of completing the dam.

3. **Soil Conservation Service.** - The Soil Conservation Service (SCS) completed a study in 1982 designed to evaluate flooding, irrigation and associated water management problems in the Sutter-Placer watershed area. The resulting report, entitled "Sutter-Placer Watershed Area Study, Sutter and Placer Counties, California," presented alternative plans and recommendations for solving flooding, declining groundwater, erosion, and other problems in the area.

4. **Federal Emergency Management Agency.** - The Federal Insurance Administration, a component of the Federal Emergency Management Agency (FEMA), is responsible for administering the National Flood Insurance Program (NFIP). A basic goal of the NFIP is the identification of flood plain areas. To

accomplish this goal, Flood Insurance Studies (FIS) are conducted and contain hydrologic and hydraulic data, maps, and profiles. The FIS's provide sufficient information to communities to enable them to adopt flood plain management measures required for participation in the NFIP. FIS's that identify flood hazard areas in the greater Sacramento area have been available since the early 1970's. These studies include the City of Sacramento (revised February 1988) and Sacramento County (partial revision November 1984). The studies have been reviewed and updated periodically since their inception and, at present, an FIS is being conducted for portions of the City and County of Sacramento.

5. State of California. -- The DWR, Central District, produced a report in 1982 entitled "A Preliminary Study of Flood Control Alternatives on the Lower American River." This report evaluated alternative methods of providing additional flood protection along the American River below Folsom Dam. (It assumed that a multipurpose Auburn Dam would not be built.) The DWR recommended that future studies emphasize possible modifications to Folsom Dam. After the floods in February 1986, the DWR produced a public information document entitled "The Floods of February 1986." It contained a discussion of daily events, pictures of flooded areas, and statistical information on statewide precipitation, flows, and damages. In a report dated December 1987, entitled "Auburn Dam Reconnaissance Appraisal of Construction under State Sponsorship," the DWR concluded it should not pursue construction of a multiple-purpose scaled-down Auburn project. However, the DWR recognized the need for flood control and local water supply and recommended support for a Corps feasibility study incorporating these purposes.

6. City of Sacramento. -- The City of Sacramento, Public Works Department, has developed an "Emergency Plan," dated October 1986, that is used with the "City of Sacramento Multihazard Functional Plan." The manual outlines procedures to be followed during various emergencies (including flooding) involving the personnel of the Public Works Department.

II. STUDY AREA DESCRIPTION

A. Study Location. - The American River watershed covers an area of about 2,100 square miles in Northern California. It lies northeast of the City of Sacramento and drains the western slope of the Sierra Nevada. It includes portions of Placer, El Dorado, and Sacramento Counties. The primary study areas included (1) the American River and its tributaries upstream from Nimbus Dam and (2) the Natomas area of Sacramento, including the Natomas East Main Drainage Canal (NEMDC), Natomas Cross Canal, and the confluence of Dry and Arcade Creeks with the NEMDC. Because of the interaction of river flows and water stages, the study also encompasses (1) the Sacramento River from the American River upstream to Verona, (2) the Sacramento Bypass, and (3) the Yolo Bypass and its pertinent tributaries and distributaries. Plate 1 is a map of the study area.

B. Existing Water Resources Projects. -

1. General. - The Sacramento River system consists of a narrow leveed river channel and two relief weirs. The system is paralleled by large, broad leveed, bypass channels. This system conveys all the floodwaters of the Sacramento River and its principal tributaries to the tidewater in Suisun Bay. Flood control features in the study area include Folsom Dam and a complex system of downstream levee and channel improvements. These features are shown on Plate 2. The American River below Folsom Dam flows into the historical flood plain (where it is leveed on both sides by private and project levees) and empties into the Sacramento River.

2. Folsom Dam. - Folsom Dam is a multi-purpose project constructed by the Corps and operated by the USBR as part of the CVP. Folsom Dam regulates runoff from about 1,860 square miles of drainage area. Folsom Lake has a normal full pool storage capacity of 1,010,000 acre-feet (ac-ft) with a seasonally designated flood control storage space of 400,000 ac-ft. Reservoir releases are controlled by two tiers of flood control outlets located in the main dam. Each tier has four outlets 5 feet wide by 9 feet high, five radial-type spillway gates 42 feet wide by 50 feet high, and three radial-type emergency spillway gates 42 feet wide by 53 feet high. The Corps Water Control Manual for Folsom Dam and Lake lists physical and operational features

of the project. Appendix A contains pertinent excerpts from that manual and related documents.

Since 1981 the Sacramento District, Corps of Engineers has been reviewing the capabilities of Folsom Dam to meet current criteria for dam safety. Two problems have been identified (1) the ability of the spillway to safely pass the Probable Maximum Flood (PMF) and (2) the potential for liquefaction and breaching of the Morman Island Auxiliary Dam and foundation during a severe local earthquake. Studies to date indicate that the existing spillway can pass only about 66 percent of the PMF. Several of the alternative flood solutions discussed in this report can beneficially affect this problem. However, the Morman Island problem exists regardless of actions taken to resolve flood problems along the American River. The USBR and Corps are pursuing efforts to initiate a corrective action as early as 1991.

3. Nimbus Dam. -- Nimbus Dam and its reservoir, known as Lake Natoma, are located about 6 miles downstream from Folsom Dam. Nimbus Dam, a power afterbay to Folsom Dam, is a diversion dam constructed and operated by the USBR also as part of the CVP. The reservoir has a capacity of 8,760 ac-ft. Because of the small capacity, it essentially has no regulatory effect on floodflows in the American River.

4. Sacramento River Flood Control Project. -- Features of the Sacramento River Flood Control Project associated with the American River Basin consist of levee improvements along the Lower American River, Natomas East Main Drainage Canal (NEMDC), Arcade Creek, Dry Creek, Pleasant Grove Creek Canal, Natomas Cross Canal, Sacramento River, Sacramento Bypass, and Yolo Bypass. The improvements were completed between 1952 and 1958. These levees are maintained by non-Federal interests.

a. American River. -- The American River portion of the Sacramento River Flood Control project consists of 10.8 miles of levee improvements along the south bank of the river upstream of Sacramento River and about 6 miles of levee improvements along the north bank of the river. The existing south bank levee along the American River was constructed in 1948 to Corps standards. The levee extends from the Mayhew Drain at Mayhew Road downstream about 10.8 miles to where it meets the left bank levee of the Sacramento River

near the mouth of the American River. The existing north bank levee was constructed to project standards in 1955. It extends from high ground near the junction of Howe Avenue and Arden Way on the east side of Cal Expo downstream about 3.5 miles to the junction with the left bank levee of the NEMDC and from the west bank levee of the NEMDC downstream (about 2.3 miles) to the mouth of the American River. The levees have a crown width of 20 feet, 1 Vertical (V) on 3 Horizontal (H) riverside slopes and 1V on 2H landside slopes. They have a gravel surface for patrol purposes. Intercepted interior drainage is collected by a system of ditches and pumped over and/or through the levees at various locations. The south bank levees were designed to accommodate 115,000 cubic feet per second (cfs) with 5 feet of freeboard. The north bank levees were designed to accommodate a flow of 152,000 cfs with 5 feet of freeboard. Both north and south bank levees were designed and built prior to construction of Folsom Dam. At that time, peak flows in the river had fairly short durations; the outflows from Folsom Reservoir have a capability for much longer durations. As a result, these levees are currently considered capable of safely accommodating sustained flows of 115,000 cfs with 5 feet of freeboard.

b. Natomas East Main Drainage Canal and Vicinity. -- Levees along the NEMDC were either constructed or upgraded as part of the Sacramento River Flood Control Project between 1955 and 1958. The west levee of the NEMDC extends from the American River upstream about 13.3 miles to high ground near Sankey Road, while the east levee extends from the American River upstream about 4 miles to Dry Creek. The reach of the NEMDC from the American River to Arcade Creek has a design capacity of 16,000 cfs, from Arcade Creek to Dry Creek between 12,500 and 12,900 cfs, and upstream from Dry Creek 1,100 cfs. At these flows the levees were designed with freeboard of at least 3 feet, except for about 1,400 feet of west levee located near Dry Creek which was designed for a freeboard of at least 2.5 feet.

As part of the Sacramento River Flood Control Project, about 2 miles of levee were constructed or upgraded along both sides of Arcade Creek from the NEMDC upstream to high ground. This work was completed in 1955. The levees were designed for a flow of 3,300 cfs with 3 feet of freeboard.

A levee along the south side of Dry Creek was constructed in 1955 as part of the Sacramento River Flood Control Project. The levee extended from the NEMDC upstream to high ground for a distance of about 1.3 miles and was designed to carry a flow of 15,000 cfs with 3 feet of freeboard.

The west levee of the Pleasant Grove Creek Canal was completed in 1958 as part of the Sacramento River Flood Control Project. This levee is about 4 miles long and extends from high ground near Sankey Road to the Natomas Cross Canal. The design capacity of the channel from Sankey Road to Curry Creek is 900 cfs, from Curry Creek to Pleasant Grove Creek is 2,700 cfs, and from Pleasant Grove Creek to the Natomas Cross Canal is 7,000 cfs. The levee was designed to have 3 feet of freeboard at these flows.

The levees along the NEMDC, Arcade Creek, Dry Creek, and Pleasant Grove Creek Canal consist primarily of fine-grained silts and clays of low to moderate plasticity with some clayey sands. A few areas have noticeably coarser materials, generally silty sands and clayey sands with a high percentage of fines. A strong layer underlying the levee embankment and low levee height suggest relatively high stability.

c. Natomas Cross Canal. -- The south levee of the Natomas Cross Canal extends about 4.4 miles between the Sacramento River and the Pleasant Grove Creek Canal. Work was completed on the south levee in 1958 as part of the Sacramento River Flood Control Project. The levee was designed to have 3 feet of freeboard at a flow of 22,000 cfs.

The south levee embankment along the Natomas Cross Canal consists primarily of fine-grained silts and clays of low to moderate plasticity and firm to stiff consistency. This levee section is generally the highest of the Natomas levees. Although there has been some landside slope instability in the vicinity of Highway 99, a recently completed geotechnical evaluation suggests that the NCC is generally stable. Additional testing and study have been proposed for portions of the NCC levee to confirm the preliminary assessment.

d. Sacramento River. -- The design flow in the Sacramento River from Fremont Weir to the American River is 107,000 cfs and downstream of the American River is 110,000 cfs. The levees along both sides of the Sacramento

river were designed to carry these flows with at least 3 feet of freeboard. The east levee of the Sacramento River from the NCC to near Sutterville Road was incorporated into the Sacramento River Flood Control Project in 1952. No additional work was required on the east levees; local interests had previously built them to meet or exceed the Corps' requirements. Similarly, the west levee on the Sacramento River from Fremont Weir to near Garcia Bend (12.5 miles) was included in the Sacramento River Flood Control Project between 1952 and 1953. However, some additional bank protection, levee set backs and levee enlargements were needed to upgrade the west levee.

The levee along the east side of the Sacramento River (also called the Garden Highway levee) consists predominantly of slightly silty sand to sand. These sands are relatively clean, poorly graded, and very loose to loose. This loose sand embankment condition exists along the levee, except for the extreme north and south ends of the 19-mile section.

e. Yolo Bypass. - The Yolo Bypass consists of a series of levee improvements beginning at the terminus of the Sutter Bypass. The Yolo Bypass receives flow from west side tributaries, the Sacramento River, and sometimes from the American River via the Sacramento Weir. When the combined flow of the Sacramento and Feather Rivers and the Sutter Bypass exceeds about 70,000 cfs, most of the excess spills over the Fremont Weir into the Yolo Bypass. In addition, when flows in the Sacramento River at the "I" Street Bridge reach a stage of 27.5 ft National Geodetic Vertical Datum (NGVD), gates at the Sacramento Weir are opened, allowing excess flow into the Yolo Bypass. During extremely high flow conditions, water from the American River will flow upstream in the Sacramento River and enter the Yolo Bypass via the Sacramento Weir. The design freeboard of the Yolo Bypass is 6 feet. The design capacity is 343,000 cfs from the Fremont Weir to Cache Creek, 377,000 cfs from Cache Creek to Sacramento Weir, 480,000 cfs from the Sacramento Weir to Putah Creek, and 500,000 cfs from Putah Creek to the Sacramento River.

5. American River Flood Control Project. - The American River Project was constructed by the Corps in 1958 and is operated and maintained by the DWR. It consists of a levee along the right (north) bank of the river (see Plate 2). The levee extends from the upstream terminus of the Sacramento River project levee near the eastern boundary of Cal Expo upstream about

8 miles to the Carmichael Bluffs. The levee has a crown width of 20 feet and land and waterside slopes of 1 on 2 and 1 on 3, respectively. The project is designed for 115,000 cfs at a minimum of 5 feet of freeboard. The project also includes pumping facilities for disposal of interior drainage. The 23-mile segment of the lower American River from Nimbus Dam to the Sacramento River has been included as a component of the State and Federal Wild and Scenic River systems. The lower American River also contains designed critical habitat of the Federally-listed endangered valley elderberry longhorn beetle.

6. Others. -

a. Non-Federal Levees. - Levees have been constructed by local developers upstream of the project levees on the south bank of the American River from the Mayhew Drain to Sunrise Boulevard. A levee constructed from the Mayhew Drain upstream about 1 mile is about 5 feet high and can probably accommodate approximately 130,000 cfs before encroachment into its freeboard. Three other levees were constructed locally; one extends from about the southern boundary of Goethe Park west approximately 1 mile; a second extends from just downstream of Sunrise Boulevard west about one-half mile, and the third separates Goethe Park from Cordova Meadows. After the February 1986 flood, the City of Sacramento extended the north bank project levee of Arcade Creek upstream about 1,100 feet to Marysville Boulevard. Local levees also crisscross the Pleasant Grove area and in general prevent floodwaters emanating from the eastern tributaries (Coon Creek, Pleasant Grove Creek, etc.) from moving south and into the NEMDC.

b. Upstream Reservoirs. - There are numerous reservoirs upstream from Folsom Dam. The most significant ones are listed in Table 1. The total storage capacity in these reservoirs is about 820,000 ac-ft. All of these reservoirs are used for water supply and/or hydroelectric power generation. None have designated flood control space. There are also minor irrigation diversions into and out of the American River Basin. Since the reservoirs are at relatively high elevations, where much of the precipitation occurs as snow, they have a minimal effect on floodflow reduction.

c. City of Sacramento Floodgates. - The City of Sacramento has a city emergency plan that includes a number of permanent and portable

TABLE 1

MAJOR RESERVOIRS IN THE UPPER AMERICAN RIVER DRAINAGE AREA

Reservoir	Stream/American River Tributary <u>1/</u>	Owner <u>2/</u>	Elev. top of Dam (ft)	Capacity (ac-ft)
Lake Clementine	N.F.	COE	716	10,600
L.L. Anderson (French Meadows)	M.F.	PCWA	5271	136,400 <u>3/</u>
Hell Hole	Rubicon Riv/M.F.	PCWA	4630	207,600
Lake Edson (Stumpy Meadows)	Pilot Cr./M.F.	GDPUD	4318	20,000
Loon Lake	Gerle Cr./M.F.	SMUD	6418	76,500
Union Valley	Silver Cr./S.F.	SMUD	4883	271,000 <u>3/</u>
Ice House	S.F. Silver Cr./S.F.	SMUD	5454	46,000 <u>3/</u>
Slab Creek	S.F.	SMUD	1870	16,600
Caples Lake	Caples Cr./S.F.	PG&E	7960	20,400
Silver Lake	Silver Fork/S.F.	PG&E	7211	3,800
Ralston After Bay	Rubicon R./M.F.	PCWA	1189	850
Chili Bar	S.F.	PG&E	1029	3,140
Gerle Div Dam	Gerle Cr./S.F.	SMUD	5240	1,380
Junction Div Dam	Silver Cr./S.F.	SMUD	4468	3,250
Camino Div Dam	Silver Cr./S.F.	SMUD	2918	290
Rubicon Sp.	M.F.	SMUD	6246	1,500
Oxbow	M.F.	PCWA	—	2,800
TOTAL				822,110

- 1/ N.F. — North Fork American River
M.F. — Middle Fork American River
S.F. — South Fork American River

- 2/ COE — Corps of Engineers
PCWA — Placer County Water Agency
GDPUD — Georgetown Divide Public Utility District
SMUD — Sacramento Municipal Utility District
PG&E — Pacific Gas and Electric Company

- 3/ Effective storage is reduced during winter months for dam safety.

floodgates. The gates are located at railroads, streets, and bike trails/ pedestrian paths where they create low points, or subways, in the levees. The general locations of these floodgates are included in Plate 2. The plan provides for all these gates to be erected or closed under specified conditions. Facilities for installation of floodgates on Arcade and Dry Creeks and the NEMDC were constructed following the 1986 flood.

C. Authorized Auburn Dam Project. - The Auburn-Folsom South Unit of the CVP was authorized in 1965 under Public Law 89-161. The unit includes Auburn Dam, Reservoir and Powerplant on the North Fork American River above Folsom Reservoir; Folsom South Canal; Sugar Pine Dam, Reservoir and conveyance; and County Line Dam, Reservoir and conveyance. The currently authorized Auburn Dam would be about 653 feet high and impound a reservoir of 2.3 million ac-ft. Auburn powerplant would have a capacity of about 300 megawatts (MW). The project would provide about 330,000 ac-ft for water supply and 600 gigawatt-hours (GWH) annually (1 GWH = 1,000,000 Kilowatt hours). When operated with Folsom Reservoir, it would provide a high level of flood protection to the Sacramento area. It would include recreation lands and facilities to accommodate 1.6 million visitor-days per year and enhance recreation opportunities at Folsom Lake through joint operation with Folsom Dam. It would mitigate certain impacts on fish and wildlife resources by maintaining stream temperatures downstream from Nimbus Dam and by managing project lands, respectively. The Folsom South Canal originates at Lake Natoma. If completed, the canal will be approximately 62 miles long and will serve irrigation and municipal and industrial users in Sacramento and San Joaquin Counties and other areas. The initial diversion capacity is 3,500 cfs. The first two reaches of canal, totaling about 27 miles, have been completed.

Since construction at the Auburn damsite began, slightly over \$233 million of Federal funds have been expended to acquire lands and rights-of-way, prepare designs and estimates, conduct geotechnical explorations, construct the upstream cofferdam and a diversion tunnel, excavate and treat the foundations for the dam and powerplant, and complete access roads and the Foresthill Bridge. In addition, approximately \$62 million has been expended in interest on the above costs. Annual operation and maintenance costs average \$1.5 million, and interest during construction is accumulating at approximately \$5 million per year. Included in Table 2 is a breakdown of the funds expended to date.

Sugar Pine Dam and Reservoir, completed in 1981, are located on North Shirttail Canyon about 7 miles north of Foresthill. The dam is an earth and rockfill structure about 197 feet high with a crest length of 680 feet. Water from the reservoir is piped approximately 9 miles to the Foresthill Utility

District service area where it is used primarily for municipal and industrial purposes.

County Line Dam and Reservoir would be located on Deer Creek about 10 miles south of Folsom Dam. The dam would be an earthfill structure about 90 feet high with a crest length of 585 feet. It would impound a reservoir with a capacity of 40,000 acre-feet, which would be used for municipal and industrial purposes in eastern El Dorado and western Sacramento Counties.

Construction of Auburn Dam and Folsom South Canal was initiated in 1967 and 1968, respectively. In 1972, the State Water Resources Control Board (SWRCB) passed Decision 1400 (D-1400), which established minimum flows along the lower American River (Nimbus Dam to the mouth) of 1,250-1,500 cfs to come into effect when Auburn Dam is completed. Until that time (and even today since Auburn has not been completed), Folsom Dam is being operated in accordance with SWRCB Decision 893 (D-893) enacted in 1958, which established minimum flows of 250-500 cfs in the lower river. Also, in 1972, a 33-foot diameter, 2,400-foot-long Auburn Dam diversion tunnel was completed. In 1975, the 265-foot-high coffer dam was completed and work was well underway on the main dam foundation. Also, in that year, the Oroville earthquake occurred and construction of the dam and powerplant was suspended pending further seismic evaluation. In 1980, the Auburn Dam was determined to be seismically safe, but construction was delayed until the downstream flow issues were resolved.

TABLE 2

AUBURN DAM PROJECT - EXPENDITURES TO DATE 1/

Project Feature	Millions (\$)
Highway 49 Lands and Relocations	1.1
Reservoir Lands and Rights-of-Way	10.8
Damsite Clearing	0.2
Recreation Lands and Facilities	5.7
Powerplant	3.2
Fish and Wildlife Mitigation Lands	0.4
Road Relocations <u>2/</u>	2.3
Auburn-Foresthill Road and Bridge	16.5
Access Roads in Reservoir Area	1.9
Diversion Tunnel	6.5
Highway 49 Bypass	3.7
Dam Foundation	96.3
Special Exploration	2.0
Building Facilities	1.2
Cofferdam	2.0
Misc. and Minor Contracts	12.2
Non-Contracts	67.9
Interest During Construction	<u>62.0</u>
Total	<u>294.8</u>

1/ Expenditures through 30 August 1986.

2/ Pacific Ave. to overlook and Indian Hill Center.

To date, no non-Federal project sponsor has been identified and construction of the Auburn project has not been resumed.

III. FLOOD PROBLEMS

A. Flood of Record, 1986. - In February 1986, large floodflows in the American River Basin caused record inflow volumes to Folsom Reservoir. A maximum 6-day inflow volume of 1,140,000 ac-ft exceeded the 6-day Reservoir Design Flood volume of 978,000 ac-ft. Because of fairly dry conditions earlier in the water year, about 200,000 ac-ft of storage space was available in the upstream reservoirs. If the flood volume that was stored in those reservoirs had been added to Folsom's inflow, the 1986 flood would have resulted in 5- and 6-day volumes greater than the Standard Project Flood volumes computed in 1961. Releases from Folsom Dam exceeded the objective outflow of 115,000 cfs for about 2 days, and it was necessary to release flows of 130,000 cfs for about 24 hours.

During the flood, significant levee damage occurred along the American and Sacramento Rivers. The erosion damage was repaired; however, should a flood similar to that in February 1986 recur, especially along the Sacramento River, sections of the Garden Highway are likely to experience further landside slope failure. The 5-foot design freeboard along the American River was encroached along the north levee in the vicinity of the "H" Street Bridge. High Sacramento River stages at the mouth of the Natomas Cross Canal combined with significant runoff from tributary streams into the canal from the east (peak runoff from the tributary streams, Coon Creek, Pleasant Grove Creek, etc., that drain toward the Cross Canal was estimated as 14,000 cfs - about a 50-year flood event), resulting in about 6,000 acres of land being flooded in the Pleasant Grove area. Minimum freeboard on the NEMDC near Main Avenue and the Cross Canal in the vicinity of the Highway 99 bridge ranged from 1 to 2 feet. In addition, floodwaters reached the understructure of the Highway 99 bridge that crosses the canal. Floodwater flowed over the east levee embankment of the NEMDC at Main Avenue. Also, levees in the Pleasant Grove area were overtopped, permitting floodwaters to move south and into the NEMDC adding to the flooding in the lower Dry Creek area and Rio Linda. A portion of these floodwaters also moved across a low point in the project levee system at Sankey Road, flooding a small area of Natomas and threatening closure of Highway 99. Emergency efforts were used to block the opening at Sankey Road and prevent overtopping of Highway 99. Several thousand acres of land were flooded east of the NEMDC between Sankey Road and Dry Creek. Flooding was

caused by runoff from the Dry Creek watershed (peak runoff was estimated at 9,500 cfs, which was about a 90-year flood event) and floodwaters entering the drain from the Pleasant Grove area.

Along Sacramento River downstream of the Natomas Cross Canal, the observed minimum freeboard was about 2.5 feet on the Natomas side. In addition, freeboard measurements of about 2 feet were observed in the vicinity of Sacramento's Old Town. Another critical area was West Sacramento where very localized sandbagging was necessary to prevent overflow of the levee embankment upstream of Business 80 on the east levee of Yolo Bypass. Other freeboard measurements in this same area included freeboard of 1 to 2 feet.

Had these high flows continued much longer or increased, major levee failure and major flooding would have been likely along the American River, NEMDC, and, as mentioned, the Sacramento River. Table 3 shows peak flows and estimated recurrence intervals at various locations in the Natomas area during the February flood.

B. Flood Protection. — The degree of flood protection along the lower American River is estimated based on the expected frequency of flows exceeding the Reservoir Design Flood (400,000 ac-ft of flood control storage with a maximum outflow of 115,000 cfs). The Reservoir Design Flood for Folsom, developed in 1945, is an estimate of the flood that would have resulted from the most critical storm that had been recorded in the climatic region. A study of the precipitation during storms of record in the region up to that time indicated that the December 1937 storm was the most critical. The Reservoir Design Flood has a peak flow of 340,000 cfs and a volume of 978,000 ac-ft of runoff in 6 days.

When Folsom Dam was constructed, protection against the Reservoir Design Flood was considered to be very high. However, primarily because of additional years of flow record, the Reservoir Design Flood is now estimated to occur much more frequently. Since the completion of Folsom Dam in 1956, three rain floods have exceeded the volume of the Reservoir Design Flood (December 1955, December 1964, and February 1986).

TABLE 3
PEAK FLOWS AND RECURRENCE INTERVALS
FEBRUARY 1986 FLOOD

Location	Runoff Peak (cfs)	Recurrence Interval (years) <u>1/</u>
Dry Creek	9,500	90
Arcade Creek	5,000	50
Natomas Cross Canal	<u>2/</u>	50
American River		
Nimbus Dam to confluence with NEMDC	130,000	70
Downstream of confluence with NEMDC	140,000	70
Sacramento River		
Verona	93,000	120
I Street	108,000	90
Sacramento Bypass		
Sacramento Weir	125,000	not determined
Yolo Bypass		
Fremont Weir	355,000	120
Lisbon	532,000	120

1/ Approximate.

2/ Inflows to the Natomas Cross Canal and Pleasant Grove Canal were about 14,000 cfs.

1. Flow-Frequency Estimates, Unregulated Conditions. -- In 1961, a statistical analysis was conducted to estimate the likely frequency of occurrence for various flows in the American River at the Fair Oaks gage downstream from Folsom Dam. This analysis indicated that Folsom Dam could control all flows up to the 120-year flood. However, after the February 1986 flood, a new flow-frequency analysis was conducted. The first step in this reanalysis was to update the unregulated rain flood volume flow-frequency relationships at the Fair Oaks gage. These relationships reflect the flow data collected for the period 1905 to 1954 and adjusted flow data for 1955 to 1986. The adjusted flows account for the effects of Folsom, French Meadows, Hell Hole, Loon Lake, Union Valley, and Ice House Reservoirs. This adjustment is necessary to provide a consistent record for statistical analysis.

Updated rain flood frequency curves, shown on Plate 3, reflect 82 years of record (1905 - 1986) for unregulated conditions for the American River at the Fair Oaks gage for 1-, 3-, 5-, 7-, 10-, 15-, and 30-day durations.

2. Flow-Frequency Estimates, Existing Conditions. - A revised peak flow-frequency curve was developed for the American River downstream from Folsom Dam. Estimated effects of storage in the reservoirs upstream of Folsom Dam in the basin were included in the derivation of the curve. The 32 years of actual recorded flow data since construction of the dam were used to define the plotting positions of flows that occur more frequently than about the 50-year exceedance interval. To help define the plotting positions of flows that occur less frequently than the 50-year event, hypothetical flood hydrographs were developed and routed through Folsom Dam. The routing assumed current criteria, some of which have been updated from that used in the operation during the February 1986 flood. The resultant flow-frequency curve is shown on Plate 4.

The flow frequency curve of Plate 4 reflects the influence of reservoir storage upstream from Folsom Lake. It includes a reduction in inflow to Folsom occurring on the rising limb of this hydrograph of 47,000 ac-ft. It was assumed this upstream storage space would be available during major floods up through about the 100-year frequency. No reductions in inflow to Folsom were made for floods larger than the 100-year event because it was assumed that preceding storms would have been sufficient to fill the upstream storage space. Only about 14 percent of the American River Basin lies above these reservoirs.

At the beginning of each hypothetical flood used for evaluating reservoir operation, Folsom Reservoir flood storage space was reduced by 80,000 ac-ft as a contingency allowance to account for deviations in realtime operation from an optimum operation that have been experienced during 20 years of actual operations.

C. Potential Flooding. - On the basis of hydrologic information and data about levee and channel conditions, and considering several basic assumptions, an estimate was made of the frequency and extent of major flooding in the study area. The assumptions dealt with the consistency of major flood events, actions by local interests, and levee failure mode. With respect to flood consistency, it was assumed that for larger flood events (i.e., about 50-year and greater) the frequency of the event would be the same everywhere in the watershed. As an example, for a 100-year floodflow release

from Folsom Dam, there would be a 100-year direct runoff event into the Natomas Cross Canal and NEMDC, and along the Sacramento River. (

Actions by local interests during a major flood event would include evacuation warning, installation of floodgates, and flood area management during and after the event. As mentioned in Chapter II, there are many flood-gate locations in the event of a major flood threat. In addition, a railroad embankment that roughly parallels the south side of the American River south project levee is expected to offer some flood protection to the downtown area. The elevation of the top of the embankment is similar to the project levee. For economic purposes in this study, it is assumed that the floodgates will be in place prior to any major levee break threat. Further, it is assumed that on Dry and Arcade Creeks, NEMDC, and at many of the locations in downtown Sacramento, the floodgates will be effective. However, it was assumed that should the south project levee fail adjacent to the City of Sacramento, the river stages would be great enough to also cause a breaching of the railroad embankment. Since the flood prevention effectiveness of the embankment depends on several critical parameters (stability of the embankment and closures and successful implementation of closure actions), this assumption appeared appropriate for this study. Following is a description of this analysis and its results.

Levees can fail for several reasons, and it is difficult to predict how and where the failures will occur. Levees have been known to fail when water stages are significantly below design freeboard. On the American River during the February 1986 storms, levee damage from erosion occurred at several locations having adequate freeboard. At other locations freeboard was encroached, but significant damages did not occur. For economic analysis in this study, the assumed levee failure mode was based on encroachment into the levee freeboard and a projection of the impacts of this encroachment on the physical system. High-water marks and recorded flows for the 1986 flood served as a guide in determining the flows and locations of freeboard encroachment. Along the mainstem of the American River, failure was assumed at varying degrees of encroachment into the freeboard based on a knowledge of levee performance during the February 1986 high water conditions. In the Natomas and West Sacramento areas, it was assumed that failure would occur when half the freeboard was encroached upon by river stage. It should be

mentioned that this analysis did not include the potential impact of future development on floodflows in the Natomas area.

1. **Levee Failure.** -- The order of levee failure is dependent on several conditions including:

- Upstream levee failures that could potentially reduce flows and stages downstream.
- Origin of flows creating a specified flood stage (or flow) in the system.
- Timing of the direct runoff hydrographs into the system.
- Duration of high flow or stage.

Based on the above assumptions, considerations, and hydrologic simulations, the first two locations of potential levee failure are the NEMDC and Yolo Bypass adjacent to West Sacramento. The critical areas on the NEMDC are the west levee embankment in the vicinity of Silver Eagle Bridge and Main Avenue. Each of these locations could potentially fail at a 50-year flood event. Flood stages at the Silver Eagle location are dependent on concurrent stages in the Sacramento and American Rivers and tributary inflow into the NEMDC, whereas the Main Avenue location is primarily dependent on tributary inflow into the NEMDC. Critical areas of the east levee embankment of Yolo Bypass, adjacent to West Sacramento, are between the Sacramento River Deep Water Ship Channel and Interstate Highway 80. The levee in this area could potentially fail at a 55-year flood event. The order of failure is not certain, based on information cited above.

The second location of levee failure was estimated to occur along the north project levee between H Street and Howe Avenue into the North Sacramento area with riverflows of 140,000 cfs (also with a return period of about once in 70 years). At this flow, the freeboard of the levee would be about 20 percent encroached upon.

The third location of levee failure was estimated to be on the south side of the river just east of the Mayhew Drain with riverflows of 140,000 cfs. The integrity of the private levee at this location is uncertain. The levee is about 5 feet lower than the project levee to the west, and it would have a remaining freeboard of only about 3 feet at a flow of 140,000 cfs.

The fourth location of failure was estimated to be into the South Sacramento area from a breaching of the Federal project levee just west of Mayhew Drain, with flows from Folsom of 180,000 cfs (return period of about 85 years). This flow was chosen since at 180,000 cfs (1) the design freeboard of 5 feet on the Federal levees would be encroached by about 2 feet and (2) the upstream private levee would have failed at a flow of 140,000 cfs, subjecting the Federal levees to outflanking with a flow of 180,000 cfs.

The next area of failure was estimated to be along the north levee east of Watt Avenue in the North Sacramento area near American River Drive, also at a riverflow of 180,000 cfs.

The last area of estimated sequential failure was into Downtown Sacramento with a flow in the river at that location of 180,000 cfs. The frequency of this occurrence mainly depends on remaining flows in the river after accounting for upstream losses due to levee breaks. The primary upstream failure that would affect the downtown area would be at the South Sacramento location. It is estimated that with an outflow from Folsom Dam of about 290,000 cfs, 180,000 cfs could reach the downtown area with a stage great enough to encroach on the levee freeboard. This condition has an estimated return period of about 125 years.

Plate 5 shows preliminary levee and water surface profile information along the American River and in the NEMDC. The information is based on construction drawings and surveys of the high-water marks taken during the 1986 peak flow of 130,000 cfs. Also shown are profiles for estimated flows in the river of 115,000, 150,000, and 180,000 cfs.

Table 4 is a summary of flows and frequencies for flood plain areas that would be affected by the assumed levee failures.

TABLE 4
FREQUENCY OF LEVEE FAILURE ^{1/}

Flood Plain	Flow (1,000 cfs) at Fairs Oaks	Stage (ft-MSL) or Flows Near Assumed Failure Location	Return Period (Yrs)
Natomas			
- NEMDC West levee in vicinity of Silver Eagle Road	115	34.6 ^{2/}	50 ^{3/}
- NEMDC above Dry Creek in vicinity of Elverta Road	210	37.0 ^{2/}	90
- Pleasant Grove Canal vicinity of Sankey Road	210	39.0	90
- Natomas Cross Canal in vicinity of Highway 99	160	39.2 ^{2/}	75
- East Sacramento River Project Levee	115	38.3	50 ^{4/}
West Sacramento			
- Yolo Bypass south of Sacramento Weir	NA	27.0	55
North Sacramento			
- Upstream "H" St. Bridge	140	140	70
- Upstream Watt Ave.	180	180	85
South Sacramento			
- East of Mayhew Drain	140	140	70
- West of Mayhew Drain	140	180	85
Downtown Sacramento	290	180	125

- ^{1/} For flood damage estimates only. Actual levee failures may occur at higher or lower flows.
- ^{2/} Stage.
- ^{3/} Failure frequency is based on concurrent events on American River and NEMDC resulting in a stage of 34.6 ft and a flow of 115,000 cfs in the American River.
- ^{4/} Failure based mainly on past performance. Sacramento River stage hydrograph at Verona was compared with timing of levee slipouts experienced during 1986 flood.

2. Flood Plains. - To help identify major areas potentially subject to flooding, a flood plain was delineated for a flow of 425,000 cfs (return period of about 200 years) along the mainstem American River. This area is shown in Plate 6. It is estimated that this flood plain covers an area of over 100,000 acres and consists of five sub-areas, depending on the location

of expected levee failures. The sub-areas include (1) Natomas, (2) North Sacramento, (3) South Sacramento, (4) Downtown Sacramento, and (5) West Sacramento. Included in Table 5 are the estimated areas and 1985 population for the flood plain areas.

TABLE 5
ESTIMATED 1985 POPULATION AND AREA IN THE 200-YEAR FLOOD PLAIN

Flood Plain	1985 Population	Area (Acres)
Natomas	22,000	47,900
Campus Commons	56,000	5,800
South Sacramento	199,000	35,200
Downtown Sacramento	48,000	8,800
West Sacramento	<u>27,000</u>	<u>5,700</u>
TOTAL	352,000	103,400

Once levee failures occur, regardless of the frequency, the flooded areas would be similar in the Natomas, Downtown Sacramento, West Sacramento, and, to some extent, North Sacramento areas. This is because (1) the ground elevation adjacent to the levees in these locations is low in comparison to the water surface in the river and (2) the volume of runoff available in the American River (and Sacramento River in the case of Natomas and Downtown) would fill the flood plains. However, for South Sacramento, the area of flooding would expand as a function of flow diverted from the American River, depending on the stage in the river.

Flooding in the Natomas and West Sacramento areas can be influenced by flows and stages in the Sacramento River. Any levee failure on the Natomas Cross Canal would permit flow from the Sacramento River to enter the Natomas area by way of the canal. In addition, runoff entering the Natomas Cross Canal from the east would also be conveyed through the breach. The volume of water passing through the breach is a function of breach size, flood stage and duration of floodflows in the Sacramento River, direct runoff into the Pleasant Grove area, and other factors. If there are several days or more of high flood stages in the Sacramento River after a breach has occurred, it would likely be sufficient to flood the entire Natomas area to significant

flood depths. A similar condition exists for the West Sacramento area. In both cases, the levee embankment heights range from 15 to 20 feet higher than the surrounding land surface.

D. Consequences of Flooding. - There would be disastrous consequences from a failure of the project and private levees because the flood plain is highly developed in residential, commercial, industrial, and public properties. An estimate was made of several potential future conditions in the flood plain, of the threat to public safety, and of the major economic damages resulting from flooding.

1. Future Conditions - For purposes of this study, the following future conditions were defined assuming no Federal flood control project was implemented.

a. Population - Population and demands for goods and services in the American River watershed will continue as currently projected. The population growth rate in the City of Sacramento and Sacramento, El Dorado, and Placer Counties is projected to exceed the growth rate for the State of California through the year 2020. Table 6 shows the projected population for these areas and for Sutter and Yolo County, based on California Department of Finance county population projections, county land use plans, availability of undeveloped land in the flood plain, estimated potential for growth and development, and extensions of historical trends.

b. Flood Mapping. - The FEMA is in the process of preparing revised flood maps for several areas in the American River watershed. These maps will likely show new areas along the American and Sacramento Rivers, and in the Natomas, Pleasant Grove, Rio Linda, and Del Paso Heights vicinities potentially subject to flooding during a 100-year event (using revised 100-year flow values). For preliminary planning purposes, it was assumed that the 100-year flood plain shown on Plate 6 would be similar to areas shown subject to flooding in the future mapping effort.

TABLE 6

PROJECTED POPULATION -- 1986-2020

Location	1987	1990	2000	2010	2020
Sacramento City	327,200 <u>1/</u>	337,769 <u>2/</u>	393,515 <u>2/</u>	458,493 <u>2/</u>	<u>3/</u>
Sacramento Co.	928,700 <u>1/</u>	993,000 <u>4/</u>	1,184,000 <u>4/</u>	1,351,200 <u>4/</u>	1,511,700 <u>4/</u>
El Dorado Co.	110,000 <u>1/</u>	123,100 <u>4/</u>	158,500 <u>4/</u>	193,900 <u>4/</u>	229,000 <u>4/</u>
Placer Co.	144,900 <u>1/</u>	159,400 <u>4/</u>	203,700 <u>4/</u>	245,800 <u>4/</u>	288,000 <u>4/</u>
Sutter Co.	59,500 <u>1/</u>	63,600 <u>4/</u>	72,000 <u>4/</u>	79,100 <u>4/</u>	85,800 <u>4/</u>
Yolo Co.	126,500 <u>1/</u>	134,100 <u>4/</u>	152,200 <u>4/</u>	168,100 <u>4/</u>	182,100 <u>4/</u>

1/ 1-1-87 Department of Finance, State of California, May 1987.

2/ Sacramento Area Council of Governments, Sacramento City 1990-2020 Projections.

3/ Data not available.

4/ 1990-2020 Projections by Department of Finance, State of California, December 1986.

c. Actions by Local Interests. - Primarily as a result of the mapping by FEMA, it is assumed in this study that the City and County of Sacramento will implement certain flood control actions. Along the mainstem of the American River, these actions initially would consist of obtaining interim additional seasonal flood space in Folsom Reservoir. However, with time, lack of implementation of a Federal project, and growing commitments by the CVP for water supply deliveries, the authorized flood space of 400,000 ac-ft in the reservoir would be retained too. At that time, the financial institutions would require existing developments within the 100-year flood plain along the river to purchase flood insurance. Any future developments (or major expansion of existing developments) would be required to provide flood proofing to the 100-year level. However, most of the lands in these flood areas are developed so the primary impact would be the purchase of flood insurance.

In Natomas, the cost of structural measures to obtain a 100-year level of flood protection is in excess of \$100 million. Because of these high costs, it is unlikely that local interests would implement a structural solution on their own. As a result, it is assumed that development will continue as projected until about 1990. After this time, and once the FEMA maps are

formally adopted, Sacramento and Sutter Counties and the City of Sacramento would require developers to flood proof their future developments. Flood proofing for any future development in this area would probably involve constructing ring levees around structures or, more likely, groups of structures and developments. In addition, it is assumed that residents in existing developments would purchase flood insurance. Because of the importance of the Sacramento Metropolitan Airport and planned development there, it is expected that the airport agency would construct one large ring levee around the facility to provide the FLMA level of protection.

Table 7 shows projections of future development in the various flood plains. The projections were prepared by local entities prior to the knowledge of a flood threat. In the Natomas area, it is likely that only about one-third of the future flood-free projection would actually occur because of the expected high cost of constructing developments compatible with the projected flood threat. Even so, for purposes of this study, it was assumed that no increase in development would occur past the year 1990 in Natomas.

TABLE 7
200-YEAR FLOOD PLAIN
LAND USE CHANGES

Flood Plain Area	Developed Areas (acres)		
	1987	2000	2050 1/
Natomas	8,000	13,300	26,400
North Sacramento	5,000	5,400	5,600
South Sacramento	27,100	33,800	33,800
Downtown Sacramento	35,500	35,500	35,500
West Sacramento	4,300	4,500	4,500
TOTAL	79,900	92,500	105,800

1/ Land use changes assumed constant after 2050.

d. Floodflows. - Without a Federal project, future floodflow conditions along the American and Sacramento Rivers are estimated to be essentially the same as present conditions. Development in the headwaters of the basins will probably not be great enough to significantly alter the inflow

frequency relationships to Folsom Reservoir. In addition, since it assumed that there would be no long term modification of the flood space in Folsom Reservoir or significant changes in downstream channel conditions, peak flow frequency conditions along the lower river would be similar to existing conditions.

Peak flows for specific events in the NEMDC and tributaries will be greater in the future because the expected development will impact hydrology. Projects requiring pumping permits and that have been approved but not constructed to date and future pumping projects necessary to minimize local flooding for potential development under the without-project condition could add between 200 to 3,000 cfs to the NEMDC and/or the Natomas Cross Canal during heavy rainfall periods. In addition, the future cumulative development under the without-project condition would result in more flow into the flood control system.

2. Public Safety. - The major adverse impact resulting from a major levee failure would be the loss of human life. The extent of the impact would depend on the location and magnitude of flooding, time of day, warning time, ability to evacuate, and effective implementation of a flood plain evacuation plan. A cursory assessment was made of the possible loss of life should a major levee fail and flooding occur. The assessment assumes the existence of a formal local evacuation plan.

Based on past floods in other areas, it can be expected that once the order to evacuate the flood plain area is given, about 20 percent of the population will either not be able to evacuate or will choose not to evacuate. These people are defined as the population at risk. As expected, the more advanced the warning, the smaller this population at risk would be. It is estimated that the flood warning time would be between 2 and 6 hours for the North Sacramento, South Sacramento, and Downtown Sacramento areas. However, in the Natomas area, the warning period could be very short since inflows to the NEMDC are uncontrolled. Given a relatively long warning period, potentially about 0.05 percent of the population at risk could lose their lives. Under existing conditions, a major flood affecting all the flood plains, such as a 200-year event, could potentially cause about 30 fatalities. However, severe flooding can occur more frequently.

On the basis of occurrences during the February 1986 flood, there would probably be little warning time to evacuate Natomas. In addition, many of the major evacuation routes, such as Highway 99 north, Main Avenue of the NEMDC, and many roads leading into the Rio Linda and Del Paso areas, would probably be flooded prior to any levee failure. If a levee breach had occurred in 1986, it could have been sudden and unexpected, and floodwaters could have very quickly covered many of the roads leading out of the area. Inability to use many of the roads during a flood emergency would make evacuation of the area extremely difficult and significant loss of life possible. Under existing conditions, assuming a short warning period (less than about 1 hour) in Natomas, and considering the potential depth of flooding, it is estimated that over 100 people could conceivably lose their lives in that area due to a levee failure.

A similar situation exists in West Sacramento where a levee breach could be sudden and unexpected. Prior to a breach in West Sacramento, roads leading out of the area would probably not be flooded (unless by local drainage) and would be usable up to the time of any levee failure. Once a levee breach occurred, however, roads could be flooded in a very short period of time, again making evacuation difficult. Because of the depths of flooding possible, loss of life could be significant.

3. Flood Damages. - Estimates were made of flood damages that would result from inundation of properties, the costs incurred for fighting the floods, and disruptions caused by floods.

The Sacramento County Assessor's rolls were used to inventory private property structures in the various flood plains and to estimate their value. The value of the damageable property in a major flood plain (200-year event for this analysis) was estimated at about \$13.8 billion (structures and contents) based on current price levels. Public property was not inventoried. Property values and flood damages for most public property in each of the flood plains were based on other Corps studies with similar flood plain development and were estimated at about \$1.1 billion. The resulting estimated property values for each of the five major flood plain areas are shown in Table 8.

TABLE 8

DAMAGEABLE PROPERTY VALUES IN THE 200-YEAR FLOOD PLAIN

Flood Plain Areas	Property Values (\$ Billion)		
	Private	Public <u>1/</u>	Total
Natomas	0.81	0.34	1.15
North Sacramento	2.86	0.02	2.88
South Sacramento	7.33	0.28	7.61
Downtown Sacramento	3.34	0.50	3.84
West Sacramento	<u>0.99</u>	<u>0.10</u>	<u>1.10</u>
TOTAL	15.33	1.24	16.57

1/ Excludes roads, bridges, and utilities.

The average flood damages, by decade, and average annual equivalent damages assuming the land uses discussed above for the without-project conditions for the flood plain areas are shown in Table 9.

TABLE 9

AVERAGE ANNUAL DAMAGES
(\$1,000,000) 1/

Flood Plain Area	Undiscounted Damages			Equivalent Damages (8-7/8%) <u>2/</u>
	1986	2000	2100	
Natomas	25	41	46	42
North Sacramento	23	26	26	26
South Sacramento	46	60	62	62
Downtown Sacramento	16	17	17	17
West Sacramento	<u>21</u>	<u>23</u>	<u>23</u>	<u>22</u>
TOTAL	131	167	174	169

1/ 1987 price level and 2000-2100 period of analysis.

2/ 8-7/8 percent Federal discount rate.

IV. PLAN FORMULATION

A. Procedure. - The process followed in plan formulation for this study was to first identify the primary planning objectives. All known measures capable of addressing the objectives were then reviewed, formulated, and compared to a set of evaluation criteria. The most desirable measures were then assembled into specific alternative plans. Last, the plans were displayed and compared to identify those warranting further development.

B. Planning Objectives. - The flood problems in the American River watershed were translated into the following planning objectives to aid in the formulation of alternative plans:

- Formulate and evaluate alternative plans to provide increased flood protection along the lower American River and in the Natomas area.
- Identify a candidate plan (or plans) that appears at this time to best satisfy Federal objectives, local needs and capabilities, and planning constraints.

C. Potential Flood Control Measures. - A variety of measures to help increase the level of flood protection in the watershed were identified for the mainstem American River and the Natomas area. They are as follows:

- Mainstem American River
 - o Increase flood control storage space in Folsom Reservoir
 - o Increase Folsom objective outflows (i.e., increase downstream levee and channel flood carrying capacity)
 - o Construct new flood control storage upstream from Folsom Reservoir
 - o Use existing upstream reservoir space for flood control
 - o Perform structural modification of Folsom Dam
 - o Construct offstream storage (or out-of-basin diversions)

- Natomas and Vicinity
 - o Construct levee improvements in and around the Natomas area
 - o Construct levees across Natomas
 - o Construct gated structure and pump facilities
 - o Construct reservoirs upstream from Natomas
- Use non-traditional methods

Following is a brief description of each measure.

1. Mainstem American River. -

a. Increase Flood Control Storage Space in Folsom Reservoir. -

Reservoir routing studies were made for various magnitudes of floods with objective reservoir releases of 115,000 cfs to estimate the effects of increasing designated flood control storage space in Folsom. Table 10 includes the resulting estimates of increased flood protection provided by this measure along the mainstem American River. This measure would increase the level of flood protection from 63 years to 75 and 94 years by increasing the flood control storage space to 500,000 and 650,000 ac-ft, respectively. Levels of flood protection for other magnitudes of increased flood space are shown on Plate 7. No structural modification of Folsom Dam is needed for this measure.

An analysis was made of the estimated economic benefits to flood damage reduction attributable to this measure. The benefits were derived by computing the residual average annual flood damages associated with the measure and subtracting these from the without-project conditions. The location and progression of estimated levee failure would be essentially the same as under without-project conditions. However, the projected frequency of failure would be dependent on the expected flow-frequency relationship in the American River developed for the various conditions. Table 11 summarizes the results of the benefit analysis. Benefits for this measure range from \$14.3 to \$29.3 million per year for storage spaces of 500,000 and 650,000 ac-ft, respectively.

Because of simplifying the levee failure assumptions in this study, flood damage reduction benefits were not considered in the Natomas or West Sacramento

TABLE 10

INCREASING FOLSOM OBJECTIVE
OUTFLOWS WITH ALTERNATIVE
FLOOD STORAGE CAPACITIES^{1/}

Measures ^{2/}		Maximum Frequency of Control	Peak Outflows from Folsom For Given Events (1,000 cfs)			
Folsom Flood Control Storage (1,000 ac-ft)	Objective Release (1,000 cfs)	(Return Period - yrs)	100-yr	200-yr	250-yr (SPF)	500-yr
400 ^{3/}	115	63	230	430	530	580
500	115	75	190	420	530	580
650	115	94	130	380	530	580
400	130	75	210	430	530	580
500	130	84	170	410	530	580
650	130	102	130	370	530	580
400	150	88	180	420	530	580
500	150	97	160	400	530	580
650	150	113	150	350	530	580
400	180	100	180	400	530	580
500	180	108	180	380	530	580
650	180	125	180	340	530	580

^{1/} Use of surcharge reservoir storage was assumed in all routing for measures not including structural modifications of Folsom Dam.

^{2/} Operating conditions

^{3/} Existing condition

areas for this or other American River measures. In actuality, however, as evident from flow and levee conditions during the February 1986 high flow period, any measures decreasing the frequency of Folsom releases in excess of 115,000 cfs would help reduce the likelihood of levee failure in these areas. This reduction will be included in any future flood control analysis.

TABLE 11

AVERAGE ANNUAL EQUIVALENT RESIDUAL FLOOD DAMAGES AND FLOOD CONTROL BENEFITS
(\$1,000,000) ^{1/}

Measure	Level of Protection	North Sacramento Area		South Sacramento Area		Downtown Sacramento Area		Total
		Return Period - yrs 2/ 3/	Residual Benefits Damages	Residual Benefits Damages	Residual Benefits Damages	Residual Benefits Damages	Residual Benefits Damages	
Folsom Flood Control Storage (1,000 ac-ft)								
400 4/	115 2/	63	26.2	0	61.6	0	17.1	104.9
500	115 2/	75	22.1	4.1	55.7	1.5	15.6	93.4
650	115 2/	94	18.2	8.0	49.8	3.8	13.3	81.3
400	130 2/	75	21.9	4.3	56.8	1.7	15.4	94.1
500	130 2/	84	19.1	7.1	52.4	2.1	15.0	86.5
650	130 2/	102	16.1	10.1	46.0	4.3	12.8	74.9
400	150 2/	88	17.6	8.6	52.3	3.6	13.5	83.4
500	150 2/	97	17.6	8.6	52.4	3.2	13.9	83.9
650	150 2/	113	14.1	12.1	45.1	5.2	11.9	71.1
400	180 2/	100	17.5	8.7	48.7	2.3	14.8	81.0
500	180 2/	108	16.5	9.7	45.3	3.6	13.5	75.3
650	180 2/	125	14.5	11.7	43.4	4.3	12.8	70.7
Lowered Folsom Spillway 15 Feet								
650	115 2/	99	17.6	8.6	48.8	2.9	14.2	80.6
650	180 2/	157	12.0	14.2	36.3	7.1	10.0	58.3
New Upstream Storage								
300	220 3/	85	19.3	6.9	51.0	2.1	15.0	85.3
300	285 3/	100	16.7	9.5	46.3	3.4	13.7	76.7
300	600 3/	200	8.7	17.5	26.3	9.1	8.0	43.0
300	620 3/	250	4.9	21.3	18.1	12.4	4.7	27.7

^{1/} 1987 price levels, 2000-2100 period of analysis, and 8-7/8 percent interest rate.^{2/} Objective release in 1,000 cfs.^{3/} Upstream flood storage in 1,000 ac-ft with objective release from Folsom Dam of 115,000 cfs.^{4/} Existing conditions.

Increasing the flood control space would result in losses of existing project accomplishments and impacts to the environment. Because greater space for flood control is needed in the winter months, in many years less water would be (1) in the reservoir in the late spring, summer, and fall, and (2) available for downstream release during certain periods. As a result, there would be a loss of existing recreational opportunities, hydropower and water supply revenues to the CVP, and unavoidable impacts to reservoir and downstream fish resources.

Primary recreation activities at Folsom Lake include vehicular camping, boat camping, picnicking, boating, and dispersed use. Downstream from the dam, the primary activities are fishing and boating (rafting). The degree of impact associated with increasing the flood control storage space would be greater for the larger flood space and would also depend on hydrologic conditions of the specific year. During normal water years at Folsom Reservoir, there would be no significant differences in the impact to summer reservoir recreation because post-flood season inflows would be great enough in most years to fill the reservoir. During dry years, however, lake visitation would be significantly reduced because of the lower surface elevation and smaller reservoir surface area. The greatest and most frequent impact would be to boating during the fall and winter periods. Under the existing requirement for 400,000 ac-ft of flood control space in Folsom, it is estimated that over 600 boats at Brown's Ravine Marina can remain in the lake all year for approximately 30 percent of the years. With either the 500,000 or 650,000 ac-ft options, all boats would need to be removed from the water by about November each year and remain out of the reservoir at least through February of the following year. This would result in an estimated loss of 20,000 recreation days annually. The impact to recreation downstream would primarily result from lower flows during certain years in the late spring and summer. It is estimated that during normal water years the impact would be minimal for either of the two increased flood space measures. However, during dry years the impact could be more significant.

Reservoir water conservation operation studies were conducted by the USBR to estimate the average annual reduction in firm water supply yield of the CVP attributable to increased flood control reservation at Folsom Reservoir. Those studies indicated that the water supply yield would be decreased by

14,000 and 33,000 ac-ft with the increase to 500,000 and 650,000 ac-ft flood control reservations, respectively. Assuming a value of replacement water supply of \$200 per acre-foot, increasing the reservation to the two spaces could have an annual cost of about \$3 million and \$7 million, respectively.

The USBR also conducted reservoir operation studies to estimate the impacts on power accomplishments resulting from increasing the flood space. They found that increasing Folsom's flood control storage to 500,000 ac-ft would have no appreciable impact on project-dependable capacity (PDC); however, it would decrease CVP average annual energy generation by 12.5 GWH per year. An increase to 650,000 ac-ft would result in a decrease of 6 megawatts in both PDC and 39.8 GWH per year in generation. In addition, there would be an increase in project pumping energy requirements at the Folsom Pumping Plant due to the lower lake surface elevations. Increases to 500,000 and 650,000 ac-ft flood control storage would result in an increase in pumping energy of 0.3 and 1.1 GWH per year, respectively. Taking the increased pumping energy into account, the total net decrease in average annual CVP generation is 12.8 and 40.9 GWH per year when increasing the flood control space to 500,000 and 650,000 ac-ft, respectively. Assuming a value of replacement generation of 100 mills per kilowatt-hour, increasing the reservation to the two spaces would have an annual cost of about \$5 million and \$6.5 million, respectively.

No reductions in the coldwater lake fishery from the lower winter lake levels would be expected because the fishery is maintained by a stocking program. However, reservoir fluctuation greater than 20 feet during spawning has the potential to reduce populations of bass and bluegill. Accordingly, there would be a slight adverse impact on this resource. It is estimated that under existing requirements for 400,000 ac-ft of flood control space in Folsom, salmon production and catch in the lower American River would be reduced from current conditions approximately 13 percent by the year 2020 due to expected increases in future water supply deliveries. This projection is not expected to change for an increase in flood control space to 500,000 ac-ft. However, for a flood control space of 650,000 ac-ft, salmon production and catch is projected to decrease 17 percent by the year 2020.

As the expected economic benefits of this measure would exceed the costs, this measure was retained for consideration in alternative plans.

b. Increase Folsom Objective Outflows. - Folsom Reservoir objective outflows are based on the design capacity of the levees and river channel downstream from the dam. Routing studies were made to estimate the potential increase in flood control for flood control storage spaces of 400,000, 500,000, and 650,000 ac-ft with releases of 115,000, 130,000, 150,000, and 180,000 cfs. Table 10 includes a summary of the increased levels of downstream flood protection provided by these measures. Plate 7 also shows the relationship of flood control storage space to exceedance intervals for 130,000, 150,000, and 180,000 cfs, respectively.

It should be mentioned that this measure, as well as measures involving levee modifications in the Natomas area, was formulated assuming that the existing levees are structurally sound and capable of accommodating their design flow. However, investigations are underway by the Sacramento District to evaluate the integrity of the existing system. These studies may show that some reaches of levee along the American River need rehabilitation.

Increased objective releases would require levee modifications at several locations downstream along the American River and tributary and distributary streams. The modification would involve raising the height of the levee to maintain adequate freeboard at various locations throughout the system depending on the amount of flow increase, placement of additional bank and levee protection along American River and several downstream river system reaches to account for the higher flow velocities, and construction of subsurface drains along the landside of the existing levee. An estimate of the location and lineal extent of the levee and related modifications is shown in Plate 8 (American River only) and Table 12 for the three increased objective releases.

Increasing the height of the levees and additional bank protection that would be required along the American River would likely be accomplished by adding embankment to the crown and to either the waterside or outside (landside) face of the levees depending on location. Locations of levee raising or placement of bank protection on the waterside face would require

little, if any, right-of-way. Also, there would be little interference with adjacent residential, commercial, and public developments. Any work on the landside levee face would require acquisition of a permanent right-of-way for construction and operation. Potential locations for levee modifications are shown on Plate 8.

Depending on the level of objective releases, there would be significant losses of riparian vegetation along the American River Parkway. These losses could result in serious impacts to fish, wildlife, recreation, and endangered species resources as well as the status of the river as a component of both the Federal and State Wild and Scenic River systems. It is estimated that the combination of bank and levee stabilization with an objective release of 130,000, 150,000 and 180,000 cfs would require the removal of between 50 and 100, 75 and 150, and 100 and 200 acres of vegetation, respectively.

Included in Table 11 are the estimated economic flood control benefits for the various objective release flows. The estimated costs for the primary features of this measure are included in Table 12.

As the estimated economic flood control benefits of this measure would exceed construction costs, the measure was retained for consideration in alternative plans.

c. Construct New Upstream Flood Control Storage. - Additional flood control storage can be achieved by constructing either a single-purpose dam and reservoir or providing space in a new multi-purpose facility upstream from Folsom Dam. Table 13 shows the estimated amount of flood control storage space needed to provide for various levels of flood protection along the mainstem American River.

TABLE 12

SUMMARY OF LEVEE MODIFICATIONS AND COSTS FOR
AMERICAN RIVER MEASURES 1/

Design Flow	Item	Location			
		Primary 2/	NEMDC & Arcade Creek	Secondary 3/	Yolo Bypass and Sacramento Bypass
(1,000 cfs)		American River		Sacramento River	
130	Feature				
	Levee Modification (mi)	4	10 4/	1	14 5/
	Bank Protection (mi)	14	0	0	4
	Toe Drains (mi)	20	0	0	0
	Lands 6/ (ac)	50	0	0	0
	Bridges 7/ (number)	0	3	0	0
	Cost (\$1,000,000)				
	Levees	45	2	0.5	6
	Structures	0	4	0.5	3
	Lands	4	0	0	0
	Subtotal	49	6	1	9
	Total Cost			65	
150	Feature				
	Levee Modification (mi)	10	10 8/	1	14 5/
	Bank Protection (mi)	19	0	0	4
	Toe/Chimney Drains (mi)	20	0	0	0
	Lands	58	0	0	0
	Bridges	0	3	0	0
	Costs (\$1,000,000)				
	Levee	62	4	0.5	8
	Structures	0	4	0.5	4
	Lands	5	0	0	0
	Subtotal	67	8	1	12
	Total Cost			88	
180	Feature				
	Levee Modification (mi)	18	10 9/	1	14 5/
	Bank Protection (mi)	21	0	0	4
	Toe/Chimney Drains (mi)	27	0	0	0
	Lands (ac)	66	0	0	0
	Bridges (number)	1	4	0	0
	Costs (\$1,000,000)				
	Levees	80	5	0.5	11
	Structures	8	4	0.5	5
	Lands	5	0	0	0
	Subtotal	93	9	1	16
	Total Cost			119	

1/ Assumes structural stability of all levee reaches.

2/ Primary-Work required along American River.

3/ Secondary-Work believed necessary to offset induced flow impacts along NEMDC, Sacramento River, Sacramento Bypass, and Yolo Bypass.

4/ Levee raised between 0.5 and 1 foot.

5/ Levee raised between 0.5 foot and 3 feet.

6/ Includes lands, easement, and right-of-ways.

7/ Includes bridge replacement or raising.

8/ Levee raised between 1 and 2 feet.

9/ Levee raised between 2 and 3 feet.

TABLE 13

NEW UPSTREAM RESERVOIR - REQUIRED FLOOD CONTROL SPACE
(1,000 ac-ft)

Level of Protection (Return Period - yrs). <u>1/</u>	Total Flood Storage	Folsom Flood Storage <u>2/</u>	New Upstream Flood Storage
63 (existing)	400	400	0
100	585	300 <u>3/</u>	285
100	600	400	200
110	650 <u>4/</u>	300 <u>3/</u>	350
150	800	400	200
200	900	300 <u>3/</u>	600
200	940	400	540
200	1,010	500	510
250	920	300 <u>3/</u>	620

1/ Along mainstem American River.

2/ Includes maintaining objective release from Folsom at 115,000 cfs.

3/ Except for existing, assumes 100,000 ac-ft of Folsom flood storage will be transferred upstream to new reservoir.

4/ Flood control space for authorized Auburn project.

As can be seen in the above table, the total flood space required for a specific level of flood protection is influenced by the amount of flood space considered in Folsom Reservoir. This is primarily because transfer of space from Folsom to a new upstream site would allow a more effective system operation for flood control. Also, studies have indicated that the least amount of total flood space that should be considered in Folsom is 300,000 ac-ft. Flood runoff in the American River Basin is about evenly split among the three main river forks (North, Middle, and South Forks). Accordingly, this translates to a runoff on the order of 300,000 ac-ft directly to Folsom and 600,000 ac-ft to the Auburn site. Also, Folsom Dam can operate to the objective release of 115,000 cfs more effectively with a stage in the reservoir corresponding to 300,000 ac-ft than 400,000 ac-ft of flood control space.

Potential reservoir sites in the Upper American River Basin are listed in Table 14 and shown on Plate 9. The most practical location for an upstream reservoir with a storage capacity large enough to provide flood space necessary to significantly reduce downstream floodflows seems to be on the

North Fork of the American River below the confluence of the North and Middle Forks in the vicinity of the Auburn Dam site.

TABLE 14
POTENTIAL RESERVOIR SITES IN THE UPPER AMERICAN RIVER BASIN

Site	Stream ^{1/}	Drainage Area (sq mi)	Av. Ann. Runoff (ac-ft/ yr)	Reservoir Storage Capacity (ac-ft)
Granite Canyon	N.F.	96	226,000	300,000
Giant Gap	N.F.	200	396,000	650,000
Growlersburg	M.F. - Canyon Cr.	12	13,900	17,500
Salmon Falls	S.F.	807	940,000 ^{2/}	200,000 ^{3/}
Alder	S.F. - Alder Cr.	19	18,600	80,000
Auburn	N.F. and M.F.	982	1,486,000	2,300,000

- ^{1/} N.F. - North Fork American River
M.F. - Middle Fork American River
S.F. - South Fork American River

^{2/} Does not include adjustments for upstream regulation.

^{3/} Maximum capacity which will not inundate Gold Discovery site at Coloma.

Table 12 includes estimated average annual flood control benefits for various levels of flood protection capable with several amounts of flood control storage space in a new dam and reservoir at or near the existing Auburn site.

In a July 1987 report, entitled "Auburn Dam Alternatives Study," the USBR evaluated five reservoir sizes. Four of the sizes, in conjunction with the Folsom Reservoir, would provide a 250-year level of flood protection along the mainstem American River. They include: (1) 650,000 ac-ft single-purpose flood control reservoir; (2) 850,000 ac-ft facility that includes incidental power and water supply; (3) 1,250,000 ac-ft reservoir to provide additional water supply and power; and (4) the authorized 2.3 million ac-ft reservoir that provides water supply, power, and instream flow. The fifth reservoir size, 315,000 ac-ft, would provide flood protection against the 100-year flood. It was assumed for each of the alternatives considered that 100,000 ac-ft of Folsom Reservoir's 400,000 ac-ft of flood control storage would be transferred to the upstream site to allow a more efficient flood operation at Folsom.

This measure would have no known significant adverse impacts on recreation, water supply, or hydropower at Folsom Lake. In fact, those accomplishments would be enhanced by the higher seasonal pool elevation. Environmental impacts associated with the authorized Auburn Dam project have been described in detail in previous reports. A single-purpose dam and reservoir would inundate fewer acres of terrestrial habitat and miles of stream than the authorized full-sized Auburn project. Significant habitat losses would occur in the dam and reservoir area. However, the losses would be somewhat less than those expected under the large Auburn Dam project. Plate 10 shows the estimated frequency of various reservoir stages of a single-purpose dam at the Auburn site, using the existing diversion tunnel modified to a 30-foot-diameter lined tunnel.

d. Use Existing Upstream Reservoir Space for Flood Control. -

It was assumed in reservoir operation studies for Folsom that 47,000 ac-ft of storage is usually available for floods equal to or smaller than the 100-year flood. This amount of storage space has been the minimum observed available in the upstream reservoirs during the flood season, and space in excess of this level is not reliable. This measure consists of using additional space in existing reservoirs upstream from Folsom for flood control. Conceptually, the additional space could be obtained in one of two ways. The first would be the purchase of space from the reservoir areas. The second would be to modify the flood control operation of Folsom Reservoir to give credit for incidental available space in the upstream reservoirs.

An order-of-magnitude estimate was made of the amount of storage space required in five upstream reservoirs (French Meadows, Loon Lake, Hell Hole, Union Valley, and Ice House) in conjunction with Folsom Reservoir to control the 100-year flood along the mainstem of the American River. It was assumed in the study that the space could be acquired from the Sacramento Municipal Utility District (SMUD) and Placer County Water Agency (PCWA) and that the outlet works at the reservoir were capable of effectively evacuating the flood space. It was found that a 100-year level of protection can be achieved through a number of combinations of either increased flood control storage space at Folsom Reservoir and/or increased Folsom objective releases, in addition to storage acquired in the upstream reservoirs.

SMUD and PCWA were requested to estimate the impacts to their reservoir systems should a total of 200,000 ac-ft of flood control space be acquired in them. SMUD estimated that the use of 85,000 ac-ft of storage in Loon Lake, Ice House, and Union Valley Reservoirs would result in an energy loss over a 30-year period (beginning in 1990) costing between \$150 and \$300 million. PCWA was unable to estimate at this time the precise economic impact to their system of the use of 115,000 ac-ft of storage in French Meadows and Hell Hole Reservoirs. However, impacts to hydropower similar to that estimated by SMUD would seem reasonable. Assuming (1) impacts at the PCWA would be similar to SMUD's and (2) the cost to acquire the space would be similar to the economic loss in hydropower generation, a major first-cost element of this aspect of the measure could amount to between \$350 and \$700 million.

Coupled with the impacts on hydropower at the reservoirs is the fact that the outlet works of each would need major modification in order to be capable of evacuating the flood space in a timely manner. On the basis of cost estimates for other projects, it is likely that modification of each of the outlet works could be between about \$10 to \$20 million. Assuming \$550 million to acquire the space and \$15 million to modify each of the outlet works, cost of this measure would be on the order of \$625 million. Assuming (1) a 100-year level of downstream flood protection (200,000 ac-ft of seasonal flood reservation in the upstream reservoir and 500,000 ac-ft in Folsom) and (2) a 6 percent allowance on the above costs for operation and maintenance, the annual costs of this measure would exceed the flood control benefits by about two to one. Accordingly, the potential of acquiring space in existing upstream reservoirs was deleted from further study.

An analysis was also made of the amount of storage space required in Folsom Reservoir to provide various levels of downstream flood protection while giving credit to periodically available space in the upstream reservoirs. This analysis showed that during many years the slightly increased level of flood control could be achieved with the flood spaces indicated in Plate 7. The analysis also showed, however, that during some years the full storage space (see Plate 7) would be required when the upstream space was exhausted. The only cost of this measure would be for establishing a program to monitor the available space in the upstream reservoirs during a storm event and to include this information into the operation of Folsom Dam.

Giving credit for space in upstream reservoirs is believed to have potential when considered in combination with other measures for helping increase the degree of flood protection at a low cost. Therefore, it was retained for consideration in alternative plans.

e. Perform Structural Modification of Folsom Dam to Permit Increased Releases. - Modifying Folsom Dam to increase the outlet operating efficiency was evaluated. This could be accomplished either by modifying the existing spillway or constructing a new spillway.

Modifying the existing spillway would allow larger releases earlier in the flood event. This modification would require lowering the crest and installing at least five new radial gates and related components. Reservoir operation studies were conducted to determine the potential for controlled objective releases of 115,000, 130,000, 150,000, and 180,000 cfs using storage spaces of 400,000, 500,000, and 650,000 ac-ft in Folsom and lowering the spillway 15 feet. The results of these studies are included in Plate 7. As can be seen on the plate, this measure would increase the degree of downstream protection only slightly when considered in conjunction with the various objective releases but fairly significantly for greater levels of space dedicated to flood control. Lowering the spillway would require longer than one construction season to complete. Accordingly, consideration would need to be given to lowering the five service bays one at a time. It is estimated that the degree of downstream flood protection would be reduced slightly during the first year or so of construction due to the limited spillway capacity. It should be mentioned that lowering all eight bays at Folsom would permit full regulation of the PMF event. There would be no vehicle movements across the dam during the construction period. There would be no known long-term impacts on water supply, hydropower, recreation, or environmental resources from this measure. The estimated first and annual cost to lower five bays of the existing spillway is \$28 and \$2.3 million, respectively. Lowering all eight bays would cost approximately \$43 million and \$3.7 million, respectively. This measure is believed to have the potential to help increase the level of flood protection in the basin and was retained for consideration in alternative plans.

The objective for constructing a new spillway would be the same as lowering the existing spillway. A likely location for a new spillway would be

near the end of the south wing dam into Willow Creek. However, as the cost of this measure would be significantly more than the cost of lowering the spillway, this measure was not considered.

Raising Folsom Dam could also create additional flood control storage space in the reservoir. However, this measure was not considered further because of the inherent difficulties associated with enlarging the existing structure and the prohibitive construction and relocation costs, as well as social and environmental impacts.

f. Construct Offstream Storage (or Out-of-Basin Diversions). -- Several measures have been identified for diverting floodflows from the American River or Folsom Reservoir into a nearby storage reservoir or out of the basin.

In earlier studies, the USBR and DWR considered a flood retention basin along Willow Creek, south of the left (south) wing dam at Folsom. Included on Plate 10 is the location of this basin. As envisioned, the basin would augment storage in Folsom. The proposal has significantly high costs and relatively little potential for increasing downstream flood protection. The DWR considered a reservoir of about 55,000 ac-ft (approximate physical limitation of the site). With this additional storage, the degree of downstream protection would be increased only slightly (from 63 to about 70 years).

It is believed that this measure has essentially no potential for effective implementation because (1) there is limited ability to increase downstream flood protection, (2) the cost would be great (DWR's estimated cost in 1982 was about \$100 million), and (3) there is significant current and expected residential and commercial development in the basin area. This measure was not considered further in this study.

A second concept would be to divert flows via a bypass conveyance system into a detention basin in the Deer Creek watershed about 10 miles south of Folsom Reservoir (see Plate 9). The costly modifications required to accommodate a high flow diversion, in addition to significant impacts in the Deer Creek and Cosumnes River basins, eliminated this concept as a viable alternative.

2. Natomas Area. -- The Natomas area can be flooded from levee breaks along the NEMDC, Natomas Cross Canal, Pleasant Grove Canal, the Sacramento River and the American River. Measures to reduce the likelihood of flooding from these sources are presented below. Flood damage reduction benefits were not developed for each of the measures. This is because they are only meaningful when the measures are combined into alternative plans providing specific levels of protection to all the Natomas area.

a. Construct Levee Improvements In and Around Natomas Area. -- Sections of levees along the west NEMDC, Natomas Cross Canal, Pleasant Grove Creek Canal, east bank of the Sacramento River, and north bank of the American River could be either raised and/or strengthened to withstand potential flooding in Natomas resulting from levee failure due to high stages. The extent of these modifications depends mostly on the level of protection desired. Below is a brief description of each. A primary assumption is that floodflows are occurring simultaneously in all the waterways. As mentioned, it is also assumed for each of the measures that the existing levee and channel system is structurally stable.

(1) NEMDC. -- To decrease the likelihood of failure of the NEMDC west levee from 50 to 100 years and from 50 to 200 years would require work along the levee including raising (1) about 3 miles of west levee an average of 3 feet and 4 feet, respectively (200-year hereafter referred to in parenthesis) immediately downstream from Dry Creek; (2) 7 (10) miles of west NEMDC levee from Elkhorn Boulevard (Main Avenue) to Sankey Road about 1 foot (0.5 to 2 feet); and (3) all bridges over the canal except the Silver Eagle and I-80 bridges. During high flows, the above modifications would result in induced flooding in the Dry and Arcade Creek areas. To offset this impact, the following would be required:

- Raise the east levee of the NEMDC from the mouth at American River to Dry Creek.
- Construct about 4 miles of new levee approximately 15 (16) feet high along the east bank of the NEMDC from near Elverta Road to the confluence of Dry Creek and continuing upstream along the north side of Dry Creek to near Marysville Boulevard.
- Extend the existing south levee along Dry Creek to the Magpie Diversion Canal.

- Excavate and widen about 3 miles of channel in Dry Creek from near Marysville Boulevard up the south side of Cherry Island.
- Raise the north levee along Arcade Creek from the NEMDC to Marysville Boulevard 2 (3) feet.
- Raise 0.3 (0.8) miles of south levee along Arcade Creek downstream of Marysville Boulevard.
- Construct 0.4 (0.6) miles of new levees on both sides of Arcade Creek upstream from Marysville Boulevard to a height of about 3 (4) feet.
- Raise or replace the bridges over Dry Creek at Elkhorn Boulevard, Rio Linda Boulevard, and Dry Creek Road.
- Raise or replace the bridges over Arcade Creek at Norwood Avenue and Marysville Boulevard. (The bridge at Rio Linda Boulevard is being replaced by the City of Sacramento.)

The estimated costs of this measure to reduce the likelihood of levee failure to the 100 (200) year events are \$50 (\$60) million. Elements of this measure along Dry and Arcade Creeks to offset induced flooding impacts would constitute about \$35 (\$40) million of this cost.

As this measure would be more effective in helping to reduce the flood threat than likely alternative measures (upstream storage and gated structure at the mouth of the NEMDC), it was retained for inclusion in alternative plans.

(2) Natomas Cross Canal and Pleasant Grove Creek Canal. - If levees were raised along either of these canals, there would be an increase in potential flooding of the area northeast of the Pleasant Grove Creek Canal. To avoid or offset the impacts associated with this increase, several options were identified. One would involve raising levees and bridges along the canals. The other would consist of a pump structure at the mouth of the Natomas Cross Canal, which is discussed in subparagraph c below. Construction of the pump station was found to be significantly less costly than levee modification. Consequently, raising the levees along the Natomas Cross Canal was not considered further.

(3) Sacramento and American Rivers - To upgrade the levees along Sacramento and American Rivers adjacent to the Natomas area to accommodate 100-year (200-year) flows would include the following:

- Raise the east levee of the Sacramento River 1 foot (2 feet) from the Natomas Cross Canal downstream for about 5 (5) miles.
- Raise the north levee of the American River from the NEMDC downstream for about 1.5 (2) miles 1 to 2 feet (1 to 3 feet)
- Place stone protection along the north levee of the American River from the NEMDC to the Sacramento River.

The estimated cost of this measure would be approximately \$43 (\$70) million.

As there are essentially no effective alternatives to this measure, it was retained for inclusion into alternative plans.

b. **Construct Levees Across Natomas.** - This measure consists of constructing levees across the Natomas area between the Sacramento River and the NEMDC. The two cross levee locations considered are (1) just north and parallel to Elverta Road and (2) just north and parallel to Del Paso Road. (There are other potential cross levee routes.) Areas north of the cross levee would not be provided additional flood protection.

A cross levee at Del Paso Road would run along most of the length of the road. At the eastern end, just east of the Sacramento City limits, the levee alignment would veer to the north and run parallel to and just west of Sorento Road. This would offer protection to the group of homes that lie between Sorento, East Levee, and Del Paso Roads. At the western end, just west of Powerline Road, the levee alignment would veer southwest to intersect Garden Highway. This is to keep the length of the levee to a minimum. The levee alignment would curve north of the I-5/Del Paso Road interchange to avoid altering the interchange. This option would offer protection for the I-80 freeway and the South Natomas area. Portions of the I-5 freeway and the Sacramento Metropolitan Airport would not be protected.

The cross levee at Elverta Road would run north and parallel to Elverta Road from the Sacramento River to the NEMDC. This option would provide protection to the Sacramento Metropolitan Airport, I-5, I-80, and the South Natomas Area.

The levees along both alignments would be constructed to a crown elevation of 42 (43) feet, which corresponds to the 100-year (200-year) water

surface elevation at Verona plus 3 feet of freeboard. The crown width would be 20 feet with sideslopes of 2H:1V landside and 3H:1V waterside. The levees would average almost 25 and 20 feet in height for the Del Paso and Elverta cross levees, respectively.

A primary disadvantage with either alignment is that no increased protection would be provided to North Natomas. Also, there would likely be some induced flooding on lands immediately north of the cross levees. A major impact of this measure over measures that would provide protection to only a portion of the Natomas area is that flood protection provided to the north area of Natomas could result in greater amounts of land being converted to higher intensive land uses. It is assumed for economic purposes in this study that there would be no development after the year 1990 in the area. As mentioned, however, future conversion of land from agricultural to other uses under a flood protection scenario will be greater than under a without project condition.

The likely alternative to this measure would consist of levee improvements along the south levee of the Natomas Cross Canal (see subparagraph a(2) above). Costs for the Natomas Cross Canal levee improvement alternative, with associated features to offset adverse impact upstream from the canal, would be significantly more than either cross levee alignment. Therefore, the cross levee measure was retained for further consideration.

c. Construct Gated Structures and Pump Facilities. - This measure consists of constructing a gated embankment structure and a pump station at the mouth of the NEMDC and/or the Natomas Cross Canal. During normal flow conditions, the gates on the embankment would be open, allowing water from the canal to discharge downstream. During high flows in the American or Sacramento Rivers, the gates would be closed, preventing river flows from entering the canal and causing backflow. Also, large capacity pumps in the canals at the structure would accommodate tributary inflows. The pumps would control the stages in the canal to avoid encroachment into the freeboard on the adjacent and upstream levees for specified design events.

(1) Natomas East Main Drainage Canal. - A gated embankment structure at the mouth of the NEMDC would reduce the likelihood of upstream

floodflow encroachment onto the canal levee freeboard and also help flow problems in the lower reaches of Dry and Arcade Creeks. Studies indicate that a pumping facility with a capacity of 12,000 and 15,000 cfs would be required to accommodate inflows primarily from Arcade and Dry Creeks from the 100- and 200-year events, respectively. Pump facilities of this size would be among the largest ever constructed. First costs for facilities to handle the two events would range from about \$68 to \$84 million, respectively. The costs of this measure would be significantly in excess of the most appropriate substituted measure, i.e., levees along NEMDC. Accordingly, this measure was deleted from further consideration.

(2) Natomas Cross Canal. - Along the cross canal, it is estimated that a pumping plant to accommodate the 100- and 200-year events would be 2,500 and 3,500 cfs, respectively. The first cost of this measure would range from \$18 to \$26 million for facilities to accommodate those events. As this measure would cost significantly less than the measure of levee rehabilitation and induced upstream flood mitigation along the drain, it was retained for further consideration.

d. Construct Reservoirs Upstream from Natomas. - This measure consists of constructing small impoundment reservoirs on various tributaries to the Natomas Cross Canal and the NEMDC. The objective of these upstream reservoirs would be to reduce inflows to the Natomas Cross Canal and the NEMDC. They would also reduce flooding on the respective creeks downstream from the structures. The Soil Conservation Service (SCS) ("Sutter-Placer Watershed Area Study," 1982) evaluated single and multiple-purpose reservoirs on 21 sites upstream of the Natomas Cross Canal. The SCS studies showed that the proposed reservoirs were too far upstream from Natomas to be very effective in controlling peak flows into the Natomas Cross Canal. Current studies by the Corps, as part of the Dry Creek Investigation, have indicated that a small dam and reservoir in the Dry Creek basin has the potential to significantly reduce floodflows into the NEMDC. However, these studies also indicate that the cost of the reservoir would likely be too great to be economically justified. This measure was deleted from further consideration.

3. Use Non-Traditional Methods. - Most traditional structural flood damage reduction measures are directed at the source of flooding. They

attempt to change the direction of floodflows, decrease the area of inundation, alter the timing of floodflows, or store floodflows. In contrast, most non-traditional measures are directed at protecting individual property, land usage, or actions during a flood. Non-traditional measures fall into several broad categories: flood proofing, evacuating structures from the flood plain, restricting development in the flood plain, and using flood warning systems.

Flood proofing could consist of temporary or permanent closure of structures, raising the existing structures, and constructing small walls or levees around the structures. Flood plain evacuation would involve either moving the structure and its contents to a flood-free site, or removing only the contents and demolishing the structure or using it for some other purpose. Development restrictions would consist of zoning, subdivision regulations, and modification of building and housing codes to require that all future development is compatible with the flood threat. Flood warning consists of forecasting flood potential; warning the population; evacuation before, during, and after a flood; and postflood reoccupation and recovery.

Because of the complexity and seriousness of the flood problem, site specific non-traditional flood damage reduction measures were not considered further in this study. However, an aggressive flood warning system and flood threat zoning program will likely need to be a part of any projected future (with- or without-project) condition in the greater Sacramento area.

D. Comparison of Measures. - Table 15 is a summary comparison of the basic flood control measures discussed above. It includes an indication of maximum levels of protection available with the measure, first cost, and relative impacts. Also included is a relative comparison of each pertinent planning criterion and a statement as to whether or not the measure was retained for further study or whether it was deleted from consideration along with the primary reason(s) why. The criteria used to compare the measures include effectiveness, efficiency, acceptability, and confidence.

- Effectiveness is defined here as the extent to which a measure can alleviate the flood problem either singularly or in combination with other measures.

- Efficiency is a relative indication of the net economic benefit of the measure to provide the specified increased flood protection. A measure suspected capable of achieving a high net economic benefit, regardless of the level of protection provided, was rated higher.

- Acceptability is the workability and viability of the measure with respect to State and local entities and the public and compatibility with existing laws, regulations, and public policies. An important factor also included in this definition for this report is the potential for a measure to either avoid or effectively mitigate significant adverse environmental impacts.

- Confidence is an indication of risk or the relative reliability of the measure to consistently provide the specified degree of flood protection in relation to other applicable measures. High levees in urban environments received a low rating because of the many factors affecting their stability and the magnitude of danger should they fail.

E. Development of Alternatives. - The primary rationale followed for formulating plan alternatives was to first develop specific flood control alternatives for American River and Natomas and vicinity separately and then for both areas in combination. For display purposes, alternatives for each of the areas were developed for at least the 100- and 200-year levels of flood protection. Estimated costs and flood control benefits for the various alternatives are from the assembly of pertinent measures for that alternative. Costs and benefits for the measures are displayed in subparagraph IV, C. First and annual costs are based on October 1987 price levels, a Federal interest rate of 8-7/8 percent, and a 100-year project life.

An environmental assessment is included as Appendix C. It summarizes base environmental conditions in the watershed and major impacts of the various measures and alternatives.

Following is a description of the alternative plans for each area.

1. No Action. — Under this alternative, the Federal Government would take no action toward implementing a specific flood control plan for the problem area. Emergency response functions and action by The FEMA would continue. The American River and its adjacent flood plains would not be altered from the without-project condition described previously. Existing fish and wildlife and recreation facilities would remain undisturbed, except when changed by flooding or unrelated processes.

2. American River. — Representative alternatives were developed for the 100-, 150-, and 200-year (or greater) levels of potential flood protection along the river. They are as follows:

a. 100-year. —

(1) Folsom Storage and Objective Release Combinations. — There are many combinations of Folsom Reservoir storage space and objective releases to achieve the 100-year level of protection along the river. Referring to Plate 7, it can be seen that combinations to control the 100-year flood range from 650,000 ac-ft in Folsom with an increase in objective releases of about 130,000 cfs to no increase in flood space with an objective release of about 180,000 cfs.

A comparison was made of levee construction/modification costs resulting from (1) accommodating greater objective releases from Folsom Reservoir and (2) the estimated reductions in water supply and hydropower benefits resulting from greater flood control storage space in the reservoir. The comparison showed that a combination having the least requirement for impacting reservoir storage space would likely be the most cost effective. However, several of the major cost items are subject to fairly wide variations. These items include specific levee and channel costs and assumptions about unit values for water supply and hydropower foregone, as well as mitigation costs for adverse impacts. Additional study is required to identify a clear superiority of storage versus objective release combinations for 100-year level of flood protection.

Because of this, two alternative combinations were developed. One focuses on maximizing objective releases from Folsom Reservoir while the other is oriented toward maximizing the flood storage space in the reservoir. These two alternatives are as follows:

- **Increase Objective Release and Channel Capacity.** - This alternative consists of increasing the objective release of Folsom Dam from 115,000 cfs to 180,000 cfs and constructing downstream facilities along the river to accommodate the higher release. As indicated in Table 12, this alternative would require raising about 18 miles of levee along the American River and placing about 21 miles of levee and bank protection along the river. Also, approximately 27 miles of drains would be needed on the land side of levees along the river. About 25 miles of levee and bank modification would be required along the NEMDC and its tributaries, in the Sacramento Bypass, and along the Yolo Bypass. The scope of the required levee and channel work is presented in paragraph IV, C.

The required bank and levee protection on the American River would result in serious environmental impacts to endangered species, anadromous fisheries, and the wild and scenic status of the lower American River. This option would also significantly impact both river and park recreation along the American River Parkway, which is estimated at over 5 million user days annually.

The estimated first and annual costs, benefits, and cost-benefit comparison for the alternative is shown in Table 16. Because of the likely significant impact the channel modification would have on the recreational and environmental character of the American River Parkway, an allowance was added for implementing project mitigation features. This allowance was assumed to be 30 percent for the American River reaches (the other reaches were assumed at 10 percent) of the major construction items. The type and magnitude of the specific mitigation features have not been defined. However, the allowance is believed appropriate and sufficient for this alternative given the significance of the resources involved.

- **Increase Flood Control Storage, Objective Release, and Channel Capacity.**
- This alternative primarily consists of (1) increasing the maximum designated

TABLE 16
SUMMARY DISP

- 1/ Assumes structural stability of all levee reaches.
- 2/ Except where noted, information is from USBR and contained in "Auburn Dam Alternative Study," USBR, July 1987.
- 3/ Due to credit given to available space in upstream reservoirs, the water supply yield and hydropower generation foregone are assumed at 90 percent of estimated losses for firm flood control spaces.
- 4/ See Table 12 for summary of levee modifications and first costs.
- 5/ Mitigation cost for (1) levee modification along American River assumed at 30 percent and (2) other areas assumed at 10 percent of first cost.
- 6/ Value supersedes information in USBR Auburn Dam report (see footnote 2).
- 7/ Value of firm water assumed to be \$200/ac-ft.
- 8/ Value of power supply assumed to be 100 mills/kWh.
- 9/ Savings in cost to Federal Government from foregoing necessity of restoring Auburn Dam site.
- 10/ Approximate net benefits and benefit-cost ratio excluding costs for Folsom Dam modifications, expenditures to date, and interest during construction.

1/ Assumes structural stability of all levee reaches.

3/ Due to credit given to available space in upstairs estimated losses for firm flood control spaces.

4/ See Table 12 for summary of levee modifications and first costs.

5/ Mitigation cost for (1) levee modification and

7/ Value of firm water assumed to be \$200/ac-ft.

8/ Value of power supply assumed to be 100 Mills/kWh.

0/ Approximate net benefits and benefit-cost ratio e

1. The first part of the paper discusses the importance of the research and the objectives of the study.

flood control storage space in Folsom Reservoir to 640,000 ac-ft and (2) increasing the objective release from Folsom Dam from 115,000 cfs to 130,000 cfs. Because space is often available in upstream existing reservoirs, during most years the flood control storage space in Folsom would only need to be increased to about 590,000 ac-ft. However, during very wet years, the full 640,000 ac-ft would be needed. It is estimated that increasing the flood space, even after considering additional interactive operation with the existing upstream reservoirs, would result in a loss of average annual firm water supply yield on the order of 28,000 acre-feet and hydropower generation of 32 GWH per year. Increasing the objective release to 130,000 cfs would require raising about 4 miles of levees along the American River and 25 miles of levee modification along the NEMDC, Sacramento River, and Yolo Bypass. It would also include placement of 14 miles of bank and levee protection and 20 miles of subsurface drains along the American River.

As shown in Table 16, the estimated first cost of this alternative is about \$80 million. Its benefit-to-cost ratio, considering losses in water supply yield and hydropower generation, would be on the order of 2.0 to 1. As with the above alternative, construction costs were increased by 30 percent to allow for implementation of environmental impact mitigation along the American River. A value of \$200 per ac-ft of water supply yield foregone and 100 mills per kWh for hydropower generation foregone was included in the benefit computation. As indicated, the yield and generation values used in computing the reduction in water supply and hydropower were reduced (10 percent for this alternative) from that mentioned in paragraph C because there is a potential to increase flood control storage through interactive operation of Folsom and upstream reservoirs.

(2) Increase Folsom Flood Control Storage and Lower Spillway.

As with the previous alternatives, there are various combinations of Folsom Reservoir storage space and objective releases in combination with lowering the spillway to achieve a 100-year level of protection. For purposes of this study, the option requiring no modification to the downstream channel was chosen for display. This is primarily because this combination would result in little or no adverse impact on the environmental resources along the downstream channel. Consequently, this alternative consists of increasing the

maximum flood control storage space to 650,000 ac-ft, lowering the crest of the five service spillways 15 feet, and replacing the five gates. In most years, the storage space would need to be increased to about 600,000 ac-ft, however, because of the potential for incidental space available in existing upstream reservoirs.

Increasing the flood space would result in a reduction in water supply yield and hydropower generation of about 30,000 acre feet and 37 GWH per year, respectively.

As mentioned in paragraph IV, C, lowering the spillways and replacing five service gates would cost about \$28 million. Costs, benefits and cost-benefit comparison for this alternative are included in Table 16. As the construction period for this alternative would be greater than 1 year, interest during that period (interest during construction = IDC) was included at the above-mentioned Federal interest rate. The IDC was computed from the date of the estimated initiation of construction until the date that essentially full flood control benefits could be achieved. In this alternative, the construction period to achieve full flood control benefit was assumed to be 5 years. Also, as shown in Table 16, this alternative would result in a reduction in water supply yield and hydropower generation from Folsom Reservoir. There would likely be some reduction in the existing level of flood protection along the river. This reduction would occur during the first year of the construction period due to two of the outlet gates and bays being out of service. Even so, this alternative would result in the largest net economic benefits and benefit-to-cost ratio of the 100-year alternatives.

(3) New Flood Control Storage. - New flood control storage was considered but not included as an alternative for providing a 100-year level of flood protection because a dam and reservoir at the Auburn site would be significantly more costly than other alternatives for this level of protection.

b. 150-Year. - Primarily because of environmental opposition to a new reservoir upstream from Folsom, a level of protection was chosen along the mainstem of the American River for which a plan not requiring a new

storage facility could be formulated. This level of protection is about 150 years. Accordingly, for comparative purposes in this study, two 150-year alternatives were formulated: one without new storage and one with new storage.

(1) Increase Flood Control Storage, Objective Release, and Channel Capacity and Lower Spillway. - This alternative consists of (1) increasing the maximum seasonal flood control space in Folsom Reservoir to 620,000 ac-ft, (2) increasing the objective release to about 180,000 cfs, and (3) lowering the existing spillway at Folsom Dam 15 feet in conjunction with installing five new gates. Approximately 43 miles of levee and channel modification would be needed to accommodate the 180,000 cfs objective release. Other information on the required channel work is included in paragraph C.

The estimated first cost of this alternative is \$180 million. Other information on costs and benefits and a cost-benefit comparison for this alternative are contained in Table 16. As shown, the first cost of this alternative is less than the new upstream storage alternative. However, the net economic benefits are less.

(2) New Upstream Storage. - Approximately 790,000 ac-ft of flood control storage is needed (assuming 400,000 ac-ft in Folsom) to control the 150-year flood along the lower American River. Accordingly, this alternative consists of constructing a 420,000 ac-ft reservoir at the Auburn site. An estimated 390,000 ac-ft of the new reservoir storage would be for active flood control and 30,000 ac-ft would be for sediment storage. The reservoir would normally be empty and would only store water for short periods during high flows in the North and Middle Forks of the American River.

The relative costs and benefits of this alternative are shown in Table 16. The benefits include a savings in cost to restoring of the Auburn site. The costs include those previously expended by the USBR on reservoir lands and relocations at the Auburn site, valued at about \$18 million. Other costs expended to date on the Auburn Dam project (see Table 2) are not included but are considered in this report as "sunk." The without-Federal-project condition is that not only will much of the dam and reservoir features not be used in the future but also that the site will be abandoned. The USBR

has indicated that costs to the Federal Government to abandon the Auburn site would be about \$50 million. Use of the site, however, would preclude this expenditure.

c. 200-Year. - For obtaining a level of flood protection along the mainstem American River greater than about 150 years or so, new storage upstream from Folsom Reservoir is required. Three dam and reservoir alternatives were formulated, one single-purpose facility for a 200-year level of protection and two multiple-purpose projects for about a 250-year level of protection.

- Single-Purpose Dam. - For the 200-year level of protection, a total flood control space (including Folsom and the new reservoir) of 940,000 ac-ft would be required. The single-purpose dam and reservoir alternative selected for display would have a total storage space of 570,000 ac-ft at the Auburn site (540,000 ac-ft effective space at the Auburn site and 30,000 ac-ft sediment storage). As with new storage alternatives described above, the reservoir space would only be used during the flood season.

- Small Multiple-Purpose Facility. - The second alternative would be an 850,000 ac-ft dam and reservoir. It would be primarily a flood control facility; however, it would have a permanent minimum pool and be capable of providing a small amount of water supply yield and hydropower. This facility would include 620,000 ac-ft of flood control space and 30,000 ac-ft for sediment storage. It would provide protection against the SPF along the lower American River. The USBR has estimated this dam and reservoir configuration would have the potential to yield about 26,000 ac-ft of firm water supply and 410 GWH of hydropower per year to the CVP. Formulation of both multiple-purpose projects assumed transferring 100,000 ac-ft of the flood control storage space in Folsom upstream to the new reservoir (i.e., reducing Folsom Reservoir storage space from 400,000 to 300,000 ac-ft). As mentioned, transferring the storage space from Folsom would allow for a more efficient operation of a reservoir system for flood control, water supply, hydropower, and recreation.

- Large Multiple-Purpose Facility. - The third alternative would be similar to the Federally authorized Auburn Dam project. It would be a large

multiple-purpose facility having a total storage space of 2.3 million ac-ft. Of this space, 620,000 ac-ft would be seasonally available for flood control. As formulated here, for comparison purposes, it would provide a similar level of flood protection along mainstem American River. The USBR estimates this project is capable of providing up to 350,000 ac-ft of firm annual water supply yield and about 610 GWH per year of hydropower.

Costs, benefits, and a cost-benefit comparison of these three alternatives are shown in Table 16. Much of the cost information in Table 16 is based on information provided by the USBR.

3. Natomas and Vicinity. - Prior to a description of the specific flood control alternatives for the Natomas area, it is important to reiterate that development of the alternatives was formulated assuming that the existing levees are structurally sound and capable of accommodating their design flow. However, as mentioned, several reaches of existing levees along the Sacramento River are not currently believed capable of safely accommodating this flow without some rehabilitation. The primary rehabilitation effort would likely consist of modifying approximately 16.8 miles of levee along the east bank of the river beginning at the American River and extending upstream to the Natomas Cross Canal. The first cost of this effort is estimated at \$30 million. In this study, it is assumed that these modifications will be completed prior to implementation of any of the alternatives mentioned below.

As mentioned, four primary measures in the Natomas area were retained for inclusion into alternative plans. They include (1) levees along the lower NEMDC with backwater levees along the lower reaches of Dry and Arcade Creeks, (2) gated structure and pumping plant at the mouth of the Natomas Cross Canal, (3) cross Natomas levee, and (4) levee improvements along the American and Sacramento Rivers. These measures were assembled into three alternatives to protect the Natomas Area. Each alternative is capable, with some modification, of providing levels of protection ranging from 100 to 200 years and more. The alternatives are as follows:

a. Natomas Area, Levee Modifications with Gated Structure and Pumping Plant. - Primary features of this alternative include the following:

- Construct a gated embankment (earthen) structure at the mouth of the Natomas Cross Canal and install a high volume pump station (about 2,500 cfs for 100-year and 3,500 cfs for 200-year protection.)
- Raise the west NEMDC levee 1 to 3 feet (4 feet for 200-year) from the mouth of American River to Sankey Road. (See paragraph IV, C.)
- Raise the east Sacramento River levee about 1 foot from the Natomas Cross Canal to Elverta Road.
- Raise or replace the Highway 99 bridge across the Natomas Cross Canal and all bridges along NEMDC except Silver Eagle and I-80.

During high flows, the above modifications would result in induced flooding in the Dry and Arcade Creek areas, increased likelihood for levee breaks along the Sacramento River and Yolo Bypass, and erosion in the Sacramento Bypass. To offset these impacts, the following was included in this alternative:

- Raise the east levee of the NEMDC from the mouth of the American River to Dry Creek.
- Construct about 4 miles of new levee approximately 15 (16) feet high along the east bank of the NEMDC from near Elverta Road to the confluence of Dry Creek and continuing upstream along the north side of Dry Creek to near Marysville Boulevard.
- Extend the existing south levee along Dry Creek to the Magpie Diversion Canal.
- Excavate and widen about 3 miles of channel in Dry Creek from near Marysville Boulevard up the south side of Cherry Island.
- Raise the north levee along Arcade Creek from the NEMDC to Marysville Boulevard 2 feet.
- Construct 0.4 (0.6) miles of new levees on both sides of Arcade Creek upstream from Marysville Boulevard to a height of about 3 (4) feet.
- Raise or replace the bridges over Dry Creek at Elkhorn Boulevard, Rio Linda Boulevard, and Dry Creek Road.
- Raise or replace the bridges over Arcade Creek at Norwood Avenue and Marysville Boulevard. (The bridge at Rio Linda Boulevard is being replaced by the City of Sacramento.)
- Raise and modify the north levee of the American River for about 1 mile downstream of the NEMDC.

In addition to offsetting induced flooding, the new levee along the north side of Dry Creek and east side of the NEMDC would also resolve the current flood problem in that area. A layout of the alternative is shown on Plate 11.

During fairly low flows, runoff to the Natomas Cross Canal would exit to the Sacramento River through gated outlets. During high flows, the gates would be closed, and runoff would be pumped from the canal. The pumping station would be designed to reduce the potential flood stages in the Pleasant Grove area and eliminate flow south toward the NEMDC for the level of protection being considered. The pumping station would also reduce the flow south toward the NEMDC for flood events greater than designed for.

Major project features and costs and benefits of this alternative, sized to provide both a 100- and 200-year level of flood protection, are summarized in Table 17. Included in the costs is a 10-percent allowance for environmental mitigation features.

b. Natomas Cross Levees. - Two alternatives were formulated for display concerning the concept of levee construction across Natomas. Each also includes levee and channel modifications along the NEMDC, lower reaches of Dry and Arcade Creeks, both banks of the Sacramento River downstream from the Natomas Cross Canal, and along the north bank of the American River between the NEMDC and Sacramento River. Each of the cross levee alternatives would include the use of pump facilities just north of the western terminus of the cross levee. The pump facilities would be used to help evacuate floodwaters from either a breach of the Natomas Cross Canal or local runoff north of the cross levee.

These two alternatives differ from the first Natomas alternative in that significantly less land would be subject to land use change. In other words, the first alternative protects the entire Natomas area, thereby allowing future development to occur in a flood-free environment. Under both the latter alternatives, progressively greater amounts of presently flood prone land would remain flood prone. Each alternative consists of a different cross levee alignment. They are as follows:

TABLE 17
SUMMARY DISPLAY
NATOMAS AREA ALTERNATIVES^{1/}

Alternatives	Modify/Construct levees along with cross levee at:			
	Del Paso Road		Elverta Road	
	100-Yr	200-Yr	100-Yr	200-Yr
Level of Protection	100-Yr	200-Yr	100-Yr	200-Yr
Features				
Levee Construction (mi)-Primary ^{2/} -Secondary ^{3/}	0 5	0 5	6 5	6.5 5
Levee Modification (mi)-Primary -Secondary	17 30	20 30	14 25	15 25
Pumping Capacity (cfs)	2,500	3,500	-	-
Area Protected (acres)	60,000	63,000	25,000	36,000
Costs (\$1,000,000)				
Investment				
Levee and Channels -Primary -Secondary	31 56	40 75	64 52	79 59
Gated Structure and Pumping Facilities	18	26	-	-
Env. Mitigation Allowance ^{4/} Total	10 115	14 155	13 146	14 152
Annual Cost				
Interest Cost and Amortization O, M, and R	10.2 0.5	13.8 0.7	13.0 0.2	13.5 0.2
Total	10.7	14.5	13.2	13.7
Benefits (\$1,000,000)				
Annual Benefits Flood Control ^{5/}	32.0	35.0	33.0	34.0
Net Annual Benefits	21.3	20.5	19.8	20.3
Benefit-Cost Ratio (to one)	3.0	2.4	2.5	2.5

^{1/} Assumes structural stability of all levee reaches.

^{2/} Primary = work required to protect Natomas area.

^{3/} Secondary = work believed necessary to offset induced flow impacts.

^{4/} Mitigation cost assumed at 10 percent of first cost.

^{5/} Does not include location benefits. If included, total project benefits would substantially increase for plan protecting entire area, moderately increase for Elverta cross levee plan, and increase somewhat for Del Paso Road plan.

(1) Del Paso Road. -- A layout of this alternative is shown on Plate 12. The alternative consists of the following:

- Construct a cross levee adjacent to Del Paso Road about 6.1 miles long with an average height and top width of 24 and 20 feet, respectively, for either 100- or 200-year levels of protection.
- Raise the west NEMDC levee 1 to 3 (4) feet from the mouth of the American River to Sankey Road.
- Raise or replace all bridges along the NEMDC except Silver Eagle and I-80.

Features to offset adverse impacts due to induced flooding would be similar to the first alternative. Features along the west bank of the Sacramento River would be restricted to raising a small reach of levee about 1 to 2 feet in the vicinity of the intersection of the cross levee. As mentioned, this measure would also include pump facilities just north of the western terminus of the cross levee.

The alternative was formulated basically to protect most of the existing developed properties in the Natomas area. The cross levee, however, would not provide flood protection to the Sacramento Metropolitan Airport or development associated with a new sports complex. Of the three Natomas alternatives, this one would result in the least amount of protected land.

A summary of costs and benefits for the Del Paso alignment for both a 100- and 200-year level of flood protection is included in Table 17.

(2) Elverta Road. -- This alternative focuses on a cross levee alignment near Elverta Road. A layout of the alternative is shown on Plate 13. The alternative provides protection to the Sacramento Metropolitan Airport and other significant currently planned developments. The levee would be about 6.5 miles long with an average height at 23 feet and a crown width of 20 feet.

A summary of costs and benefits for both a 100- and 200-year level of protection is included in Table 17.

4. Combination Plans. -- There are benefits, primarily resulting from savings in construction costs, by considering both the mainstem American River and Natomas area in single-basin plans. Numerous combinations of the measures included in the previously discussed alternatives are capable of providing various levels of flood protection in the American River watershed. Three were formulated for display here, two for a 100-year level of protection and one for a 200-year level. They were chosen to generally represent those likely to be capable for selection and ultimate implementation. It was assumed in each alternative that the entire Natomas area would be protected. Accordingly, the Natomas portion of the alternatives included a gated structure with pumping plant at the mouth of the cross canal and levee improvements along the NEMDC and Sacramento and American Rivers. A summary of the alternatives is shown in Table 18.

a. 100-Year. -- Two alternatives were developed to achieve a 100-year level of protection. One minimizes modifications at Folsom Dam and Reservoir, and the other minimizes modification of the downstream channel.

-- Increase Folsom Objective Release, Downstream Channel Capacity, and Natomas Improvements. -- This alternative consists of increasing the objective release from Folsom Dam to 180,000 cfs along with channel modification along the American River to accommodate the higher flows. It also includes modifications in the Natomas area similar to the alternative in Table 17, including a gated structure and pumping plant on the Natomas Cross Canal.

-- Increase Folsom Storage, Lower Spillway, and Natomas Improvements. -- This alternative consists of lowering the spillway of Folsom Dam 15 feet, replacing the five service spillway gates, and increasing the flood control storage space in the reservoir to 650,000 ac-ft. Features in the Natomas area and vicinity would be similar to the gated structure and pumping plant alternative described above. The primary cost savings benefit of this alternative results from significantly less levee upgrading required in Natomas than in the increased objective flow alternative because the objective release from Folsom Dam would be retained at 115,000 cfs.

TABLE 18
SUMMARY DISPLAY
COMBINATION ALTERNATIVES^{1/}

Level of Protection	100-Yr		200-Yr
Alternative	Increase Folsom Objective Release and Construct Natomas Improvements	Increase Folsom F.C. Storage Lower Spillway and Construct Natomas Improvements	Construct New Storage (Single-Purpose Reservoir) and Natomas Improvements
Features			
Reservoir Storage (ac-ft)			
Folsom Reservoir F.C.	400,000	650,000	400,000
New Reservoir	-	-	570,000
Total	-	-	540,000
Flood Control	-	-	115,000
Folsom Objective Release (cfs)	180,000	115,000	-
Lower Folsom Spillway (ft)	-	15	-
Levee Modification (mi)	-	-	-
American River	-	0	0
Natomas Area - Primary ^{3/}	15	14	21
Other Areas - Secondary ^{4/}	31	30	30
Natomas Cross Canal	-	-	-
Pump Capacity (cfs)	2,500	2,500	3,500
Costs (\$1,000,000)			
Investment			
Levees and Channels			
American River - Primary	93	-	-
Natomas Area - Primary	24	18	22
Other Areas - Secondary	56	48	60
Folsom Dam Modification	-	28	-
New Dam and Related	-	-	272
Gated Structure and Pumping			
Facilities	18	18	26
Env. Mitigation Allowance ^{5/}	38	11	38
Subtotal	229	123	418
Interest During Construction	-	3	23
Total	229	126	441
Annual Cost			
Interest and Amortization	20.3	11.2	39.1
O, M, and R	1.0	.9	1.8
Total	21.3	12.1	40.9
Benefits (\$1,000,000)			
Annual Benefits			
Flood Control	55.9	56.3	96.9
Water Supply	-	-5.9 ^{6/}	-
Hydropower	-	-3.7 ^{7/}	-
Auburn Dam Savings	-	-	5.0
Total	55.9	46.7	101.9
Net Annual Benefits	34.6	34.6	61.0
Benefit-Cost Ratio (to one)	2.6	3.8	2.5

1/ Assumes structural stability of all levee reaches.

2/ See Primary work items in Table 12.

3/ Primary = work required to protect Natomas Area.

4/ Secondary = work believed necessary to offset induced-flow impacts.

5/ Mitigation costs for (1) levee modification along American River assumed at 30 percent and (2) other areas assumed at 10 percent of first cost for the other items.

6/ Value of firm water supply Folsom assumed to be \$200/ac-ft.

7/ Value of power supply foregone assumed to be 100 mills/kWh.

The main savings in costs of these alternatives over addition of similar plan elements from the American River and Natomas area alternatives occur primarily along the NEMDC, north bank of the American River near the Sacramento River, and in the Yolo and Sacramento Bypasses. In other words, the cost of levee and channel modifications in these areas would be less for the combination plan than the sum of costs for work in the areas in the American River and Natomas area alternatives.

As can be seen in Table 18, net economic benefits for both alternatives are similar. The first alternative (180,000 cfs objective release) would require significant modification to the downstream channel while the second would primarily result in losses in future water supply yield and hydropower potential.

b. 200-Year. - The alternative to provide a 200-year level of protection chosen for display includes, primarily, a single-purpose dam and reservoir at the Auburn site and the same features in the Natomas area and vicinity. Table 18 includes a list of pertinent features for the alternative and a comparison of benefits and costs.

F. Comparison of Alternatives. - Tables 19 and 20 show a summary comparison of the alternatives described above along the American River and in the Natomas area. A similar comparison was not done for the combination plans, primarily because they represented only several ways the various measures could be assembled. As shown in the tables, the planning criteria of completeness, effectiveness, efficiency, confidence, and acceptability are compared for each of the alternatives. With the exception of completeness, each criterion is defined in paragraph IV, D. Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. The comparison is accomplished with a numerical rating from one to three. A rating of one indicates little satisfaction with the criterion. A rating of three indicates a high satisfaction. Estimated major advantages and disadvantages of each alternative are also included in the tables. They are included to support the relative numerical ranking above.

Table 19 shows that alternatives along the American River providing higher levels of flood protection appear to rate higher when compared to the criteria. For the lower levels of flood protection, those alternatives requiring less modification of the downstream channel appear superior. There are several primary reasons for this. First, environmental sensitivity of the downstream channel makes implementation of effective mitigation for adverse impacts very difficult. Second, no matter how effective the mitigation would be, the required channel work may not be publicly acceptable. Accordingly, both these alternatives show low acceptability. Third, there is a lower confidence level associated with modifying the levee system to safely accommodate significantly higher floods as opposed to increasing reservoir storage for a highly urban environment.

For the Natomas area, construction of a pumping station structure at the mouth of the Natomas Cross Canal, along with other levee construction and modification, appears to be the best alternative for the 100-year and 200-year levels of protection (see Table 20). From an environmental perspective, however, the Natomas cross levee alternatives would result in less changes in land use in the north Natomas area and may be more environmentally acceptable.

G. Potential NED Alternative. - Identification of the National Economic Development (NED) alternative(s) is important to help in defining the Federal interest and degree of potential cost sharing in a project. Current cost-sharing percentages apply to that alternative which maximizes NED. For larger, more costly projects, local interests would be required to fund the added increment. For smaller, less costly projects, the established cost-sharing percentages for the NED alternative would usually apply.

1. Current Analysis. - For the American River alternatives, Table 16 shows that the NED plan provides a high level of flood protection. As can be seen, the higher net benefits are associated with construction of new storage upstream from Folsom Dam. Additional study is required to precisely identify the size and scope (single- or multiple-purpose) of a dam and reservoir project that maximizes net benefits.

TABLE 19

COMPARISON - AMERICAN RIVER ALTERNATIVES

Alternative Level of Protection (yrs): Description	100			150		200 (or Greater)	
	Incr Obj. Release & Channel Cap.	Incr F.C. Stor, Obj Rel, & Channel Cap.	Incr F.C. & Lower Spillway: Obj Rel, & Lower Spill- way	Construct New Storage	Dry Reser- voir	Small Multi- purpose Reservoir	Large Multi- purpose Reser- voir
-Relative Rating							
Completeness	1	1	1	3	3	3	2
Effectiveness	1	1	2	2	3	3	3
Efficiency	1	1	1	2	3	2	3
Confidence	1	1	1	3	3	3	3
Acceptability	1	2	1	1	1	2	1
Total	5	6	6	11	13	13	12
-Major Advantages	No reduction in existing system benefits at Folsom -FEMA level of flood protection	FEMA level of flood control	-Rel high level of flood protection -FEMA level of flood protection -Highest benefits fits for 100-year plans -Minimal env impacts	-Rel high level of flood protection -High net benefits in existing system fits at Folsom	-High level of flood protection -Highest net benefits of F.C. plans in existing system -No reduction in existing system benefits at Folsom	-High level of flood protection -Provides some water & power benefits -No reduction in existing system benefits at Folsom	-High level of flood protection -Maximizes full potential of site for water development -No reduction in existing system benefits at Folsom
-Major Disadvantages	-Significant increase in flows and velocities in Amer R -Levee system impacts less than desirable level of protection for metro area protected by high levees	-Mod increase in flows and velocities in Amer R -Reduction in existing system benefits -Mod env impacts less than desirable level of protection for metro area protected by high levees	-Reduction in existing system benefits at Folsom -Less than desirable level of protection for metropolitan area protected by high levees	-Does not maximize full potential of site for water development	-Does not maximize full potential of site for water development	-Significant loss of upland and riverine habitat	-Significant loss of upland and riverine habitat

TABLE 20

COMPARISON -- NATOMAS AREA ALTERNATIVES

Alternative Description Level of Protection (yrs)	Construct Levees With Gate/Pump at Mouth of NCC		Construct Levees		Cross Levee	Elverta Road	Cross Levee	Cross Levee
	100	200	100	200		100	200	
--Relative Rating								
Completeness	3	3	2	2		2		2
Effectiveness	3	3	1	1		2		2
Efficiency	2	3	2	3		2		3
Confidence	2	2	2	2		2		2
Acceptability	3	3	1	1		2		2
Total	13	14	8	9		10		11
Major Advantages	FEMA level of flood protection for entire Natomas area and lower Dry Creek area	High level of flood protection for entire Natomas area and lower Dry Creek area	FEMA level of flood protection for Natomas area and parts of Dry Creek area	High level of flood protection for Natomas area and parts of Dry Creek area		FEMA level of flood protection for Natomas area and parts of Dry Creek area		High level of flood protection for Natomas area and parts of Dry Creek area
Major Disadvantages	Mod env impacts due to riparian and wetland losses Mod to significant env impacts due to growth inducement Less than desirable level of protection for metro area protected by high levees	Mod env impacts due to riparian and wetland losses Mod to significant env impacts due to growth inducement Less than desirable level of protection for metro area protected by high levees	Partial flood protection for Natomas area Minor env impacts due to riparian and wetland losses Minor env impacts due to growth inducement Less than desirable level of protection for metro area protected by high levees	Partial flood protection for Natomas area Minor env impacts due to riparian and wetland losses Minor env impacts due to growth inducement Less than desirable level of protection for metro area protected by high levees		Partial flood protection for Natomas area Minor env impacts due to riparian and wetland losses Minor env impacts due to growth inducement Less than desirable level of protection for metro area protected by high levees		Partial flood protection for Natomas area Minor env impacts due to riparian and wetland losses Minor env impacts due to growth inducement Less than desirable level of protection for metro area protected by high levees

For the Natomas area (referring to Table 17) at this level of study, it appears that the alternative including a gated structure with pump station at the mouth of the Natomas Cross Canal and levee improvements at other locations would achieve the greatest NED benefits. However, the net benefits for each of the alternatives are fairly similar.

As might be expected (referring to Table 18) for the combination plan, higher levels of flood protection appear to provide the highest net benefits. It should be noted that combinations of measures providing higher levels of protection along the American River and lower levels of protection in Natomas may be found in future studies to maximize net economic benefits.

2. Location Benefits. - Location benefits, also known as land enhancement benefits, are based on the difference in fair market value of land under "with" versus "without" Federal flood control project conditions. There are several ways location benefits can be calculated.

As indicated, no future development was assumed in Natomas after the year 1990, and location benefits were not estimated. However, as noted in Chapter III, the rate and amount of development in Natomas would increase if the area were provided additional flood protection, and location benefits would likely result. Accordingly, location benefits will be evaluated in future feasibility studies. It is believed, however, that since significantly more benefits would occur in areas not now developed (i.e., Central and North Natomas), the impact of this benefit would be an increase in the net economic feasibility of those plans protecting more of the Natomas area.

V. FEASIBILITY PHASE STUDIES

A. General. -- From studies and their results described in this report, it appears that there are economically feasible solutions to the identified flood problems. Further, more detailed feasibility studies will be needed to precisely identify and define the plan that has local, State, and Federal support for construction and for which environmental impact studies should be accomplished. It should be reiterated that studies to date were conducted in accordance with language in the 1987 Appropriations Act. Specifically, it was assumed in this study that the Auburn Dam as previously authorized would not be constructed. However, Auburn Dam is a Federally authorized project for construction. Recent Congressional direction contained in a Fiscal Year 1988 Continuing Resolutions Act apparently has resolved a potential inconsistency concerning the current status of the Auburn Project and accomplishment of feasibility studies, including a potential dam and reservoir at or near the Auburn site by the Corps of Engineers. This directive is as follows:

"...The conferees are aware that recent information presented by the Corps and the Bureau in a series of three fact-finding hearings in Sacramento reveals that the region may be under a greater threat from serious flooding than was previously believed. It is also clear that any improvements which may be made to increase the level of flood control on the American River may not by itself alleviate the flood danger to the northern part of Sacramento County east and west of the Natomas East Main Drainage Canal, which includes the Natomas area and the Dry Creek watershed. The conferees therefore urge the Corps of Engineers to examine potential flood control improvements to the Natomas and the Dry Creek watershed concurrent to the Corps' evaluation of improving flood protection on the American River. The conferees further recognize that there may be additional flood protection afforded by a primarily peak-flow flood control facility (the so-called "dry dam") on the North Fork of the American River above Folsom Dam. The conferees therefore direct the Corps of Engineers to include further assessments of the relationship between such a peak-flow flood control facility and the operation of Folsom Dam as they may pertain to incidental water, power and recreational benefits. Within this assessment, the Corps should include its analysis of the current and projected water supply demands in the American River basin."

B. Candidate Plans. -- On 19 April 1987, the Sacramento County Board of Supervisors adopted a resolution indicating that a 100-year level of flood protection may not provide adequate levels of protection to Sacramento and supported continued studies (see Appendix B). In a Sacramento City Council resolution adopted on 5 May 1987, a 200-year minimum level of flood protection was recommended (see Appendix B). In addition, as part of recent coordination

for feasibility phase studies with the potential non-Federal sponsor and the sponsor's cost sharing partners (see paragraph C below), a high (200 years or greater) level of flood protection was selected for future consideration (see paragraph D). Further, as a result of recent hearings conducted by Congressmen Fazio, Matsui, and Shumway on the flood problems in the Sacramento area, it is evident that certain alternatives are preferred. Because of the resolutions provided by the City and County of Sacramento, results of the Congressional hearings, coordination with the potential local sponsor, and results of the above comparison of alternatives, several candidate plans have been selected for further study. These candidate plans are similar to the alternatives previously described. They are as follows:

- Mainstem American River

- o Single-purpose dam at or near the Auburn site for flood control (no minimum pool but with possible provisions to help firm-up water supply yield and hydropower at Folsom).

- o Single-purpose dam at or near the Auburn site for flood control as above but with provisions for later enlargement for other purposes.

- o Dam at or near the Auburn site primarily for flood control but with provisions to capture runoff for local water supply during the non-flood season (non-firm water supply and no minimum pool).

- o Dam and small permanent pool reservoir at or near the Auburn site for flood control, local water supply, and possibly some hydropower.

- Natomas Area and Vicinity

- o Protection for all of the Natomas area (and lower Dry Creek) consisting of upgrading existing levees, constructing new levees, and constructing a gated/pumping station facility at the mouth of the Natomas Cross Canal.

o Protection for a portion of the Natomas area (and lower Dry Creek) consisting of constructing a cross levee and appurtenant facilities at a location to be mutually agreed upon, and upgrading of other pertinent levees.

C. Non-Federal Sponsor's Views. - Current Federal cost-sharing laws state that a non-Federal local sponsor will share 50 percent of the feasibility phase study costs. Therefore, the local sponsor will have a strong financial interest in those studies. In a letter dated 18 September 1987, The Reclamation Board of the State of California offered to be the local sponsor for feasibility studies (see Appendix B). The Reclamation Board is coordinating with the DWR in order for the DWR to share in the local sponsorship for any water supply increment of future studies. The Reclamation Board is also coordinating with other local interests to cost share in the 50 percent local portion of the feasibility study. Representatives from The Reclamation Board, DWR, and other supporting interests have indicated a strong support for studies of the candidate plans outlined above.

D. Required Studies. - A large number of studies will be required during the feasibility phase of the investigation. A scope of work, cost estimate, and schedule for the feasibility study are appended to a Feasibility Cost-Sharing Agreement (FCSA). The FCSA is between the Department of the Army (represented by the Sacramento District Engineer) and the non-Federal sponsor and identifies the equal sharing of the costs for the feasibility study. Accompanying submission of the FCSA for approval is a letter of intent from the non-Federal sponsor stating that the FCSA is acceptable and that the sponsor will sign the agreement upon certification of the reconnaissance report. The currently estimated total cost of the feasibility phase is \$2.5 million. Under an optimum funding scenario, the feasibility study phase will take about 28 months to complete (Sacramento District will submit final feasibility report and environmental impact statement to South Pacific Division, Corps of Engineers).

E. Study Management. - The non-Federal sponsor will be involved in study management. In order to address the challenges involved in managing a cost-shared study, an Executive Committee and a Study Management Team will be formed. This management structure will be formalized in the FCSA.

The Study Management Team will include the Corps of Engineers, the non-Federal sponsor and the sponsor's cost-sharing partners, and other pertinent entities. This team will function as the body that develops the studies, guides in their accomplishment, and participates in selection of potential solutions. The team will be directly involved in establishing mutual roles and interests and in focusing on the critical issues. Corps representatives will include the study manager and the Chief, Sacramento Basin Branch (Planning Division). The team will recommend to the Executive Committee the nature of tasks to be conducted and extent of planning and evaluation to be carried out in the feasibility phase. It will also report on the results of studies to the committee and recommend alternative courses of action for project implementation.

The Executive Committee will include the District Engineer and his chief planner or designee. The sponsor and the sponsor's cost-sharing participants, along with primary technical advisors, will be equal partners with the Corps representatives on the Committee. The District Engineer and his counterparts with the State of California (Director, DWR and President, Reclamation Board) will co-chair the Committee. Other members of the Executive Committee are likely to be as follows:

- One member of the Board of Supervisors from Sacramento, Sutter, Placer, and El Dorado Counties.
- One council member from the City of Sacramento.
- One board member from Reclamation District 1000.

The Executive Committee will participate in Issue Resolution Conferences (IRC) and ratify decisions made by the Study Management Team. The Committee is also responsible for resolving any disputes that may arise during the study. The Committee shall agree on the solutions and study direction, which may include termination. At least one conference will be held prior to the feasibility phase to ensure that all issues are resolved prior to submitting the report to higher authority. Additional IRC's will be held, as required, throughout the study to resolve any problems which may arise.

The Corps study manager will be required to perform both the general supervision of personnel involved in the study effort and the management of

the study itself. He will ensure that funds are allocated to the proper organizational elements and that appropriate analyses are conducted to develop the information needed to address the resource problems of the watershed. He will also direct the flow of information between organizational elements and the Sponsor in order to accomplish the work in a systematic and timely manner.

F. Financial Analysis.

1. **Feasibility Phase.** - As mentioned, the feasibility phase will be cost shared 50 percent Federal/50 percent non-Federal. The State of California will divide these non-Federal costs among the above-listed recipients of the proposed project benefits. Study costs will be funded from the yearly working budgets of these organizations. The non-Federal fiscal year begins in July, and the study costs for the first year have been set aside in their respective budgets.

2. **Construction Phase.** - The cost of constructing the project will be shared in accordance with the Water Resources Development Act of 1986. During construction of a project, the non-Federal sponsor must pay 5 percent of the costs assigned to flood control. In addition, the sponsor must provide all lands, easements, rights-of-way, and relocations. If the total of the two of these is less than 25 percent of the total construction cost, the sponsor will pay the difference during construction. However, the total non-Federal cost will not exceed 50 percent of the total project cost.

One factor possibly affecting the sharing of construction costs is the potential for windfall benefits. Should a few individuals or interests stand to significantly gain financially from Federal participation in a project, then the non-Federal project sponsor(s) would be required to pay more of the construction costs. The only known location in the study area where this may become an issue is in Natomas. Plate 14 provides a breakdown of land ownership. It shows that numerous interests own large land parcels (5 acres and greater). Parcels smaller than 5 acres were too numerous to compile in the time available for this cursory analysis. Because of the numerous land-owners in Natomas, it appears that windfall benefits will not occur. However, this will be addressed further in the feasibility phase.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions. -

- A serious flood threat exists along the lower American River and in the Natomas area.

- About 350,000 people live in the flood plain of the lower American River, and the value of potential flood damageable property is in the billions of dollars.

- Recent hydrological and reservoir operation analyses indicate that the degree of flood protection for the Sacramento area is significantly less than previously thought.

- It is estimated that current operation of Folsom Dam and Reservoir can control objective downstream releases (115,000 cfs) for floods up to the 63-year event.

- The estimated average annual equivalent flood damages in the flood plain of the American River amount to about \$170 million.

- The potential for loss of life is moderately high and can be reduced by implementing higher levels of protection than currently exist.

- Along the American River, 100- to 150-year levels of protection can be economically achieved through various combinations of Folsom Dam modification and downstream levee and channel modifications.

- Levels of protection in excess of 150 years along the lower American River can be economically achieved by constructing new storage upstream from Folsom Reservoir.

- For either all or part of the Natomas area, 100- to 200-year levels of protection can be achieved through economically feasible alternatives at similar costs for these levels of flood protection.

- Studies assumed structural integrity of the existing levee system. However, it is likely that levees along the Sacramento River adjacent to the Natomas area and possibly several reaches along the American River are not structurally capable of accommodating their design flows and may need restoration prior to (or in conjunction with) implementing any of the alternatives, including levee modification.

- The State of California and various local interests, including Sacramento County and City, Sutter County, and Reclamation District 1000, are strongly interested in and supportive of solutions to flood problems in the American River watershed.

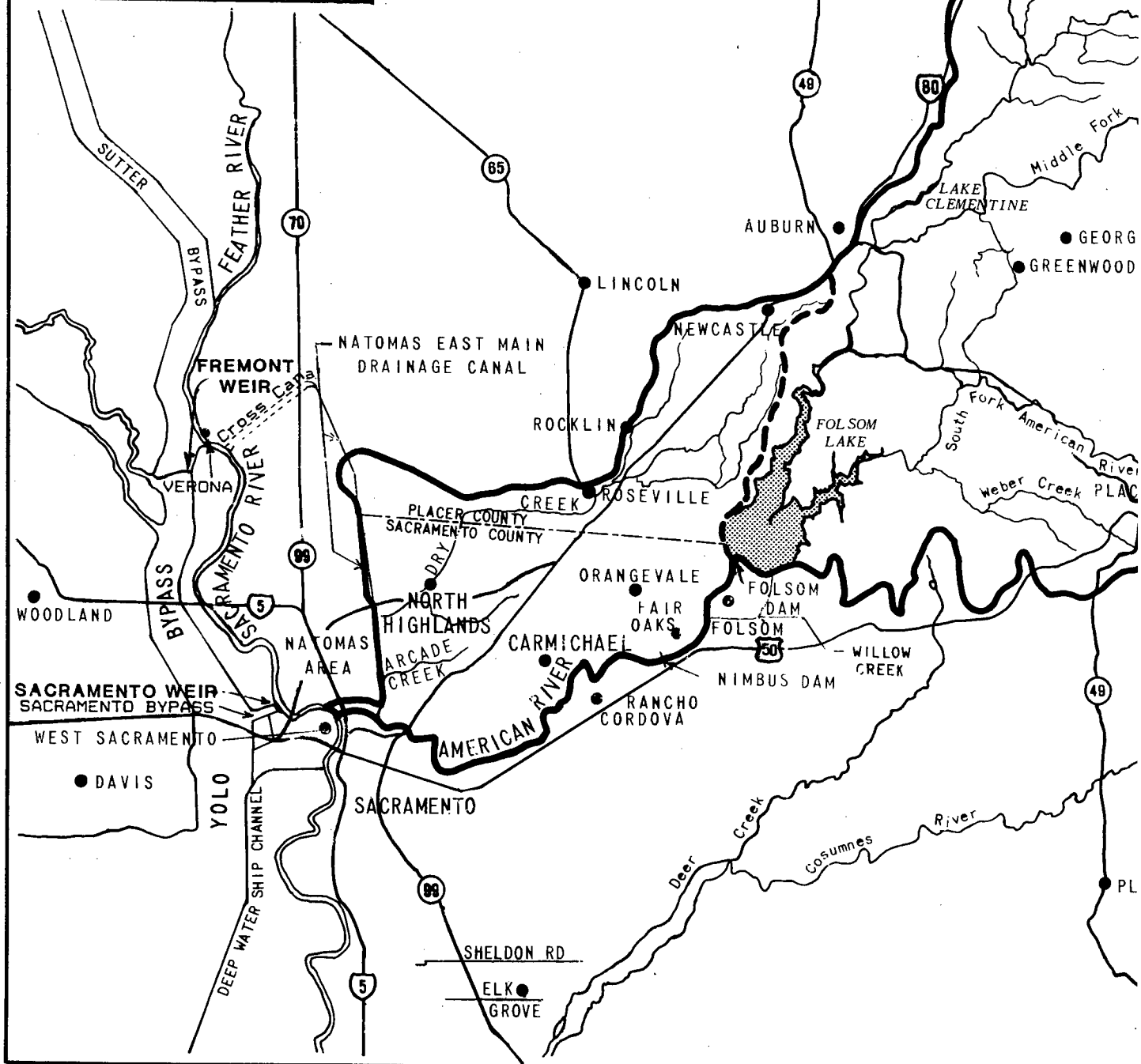
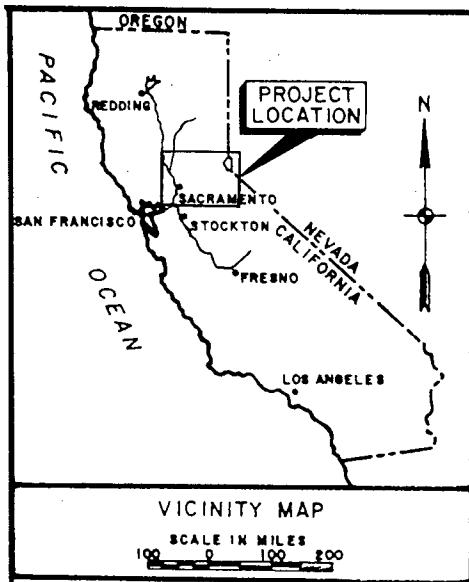
- The State of California, with participation of other local beneficiaries of a flood control project, has stated its intent to act as the sponsor of feasibility studies of the American River Watershed.

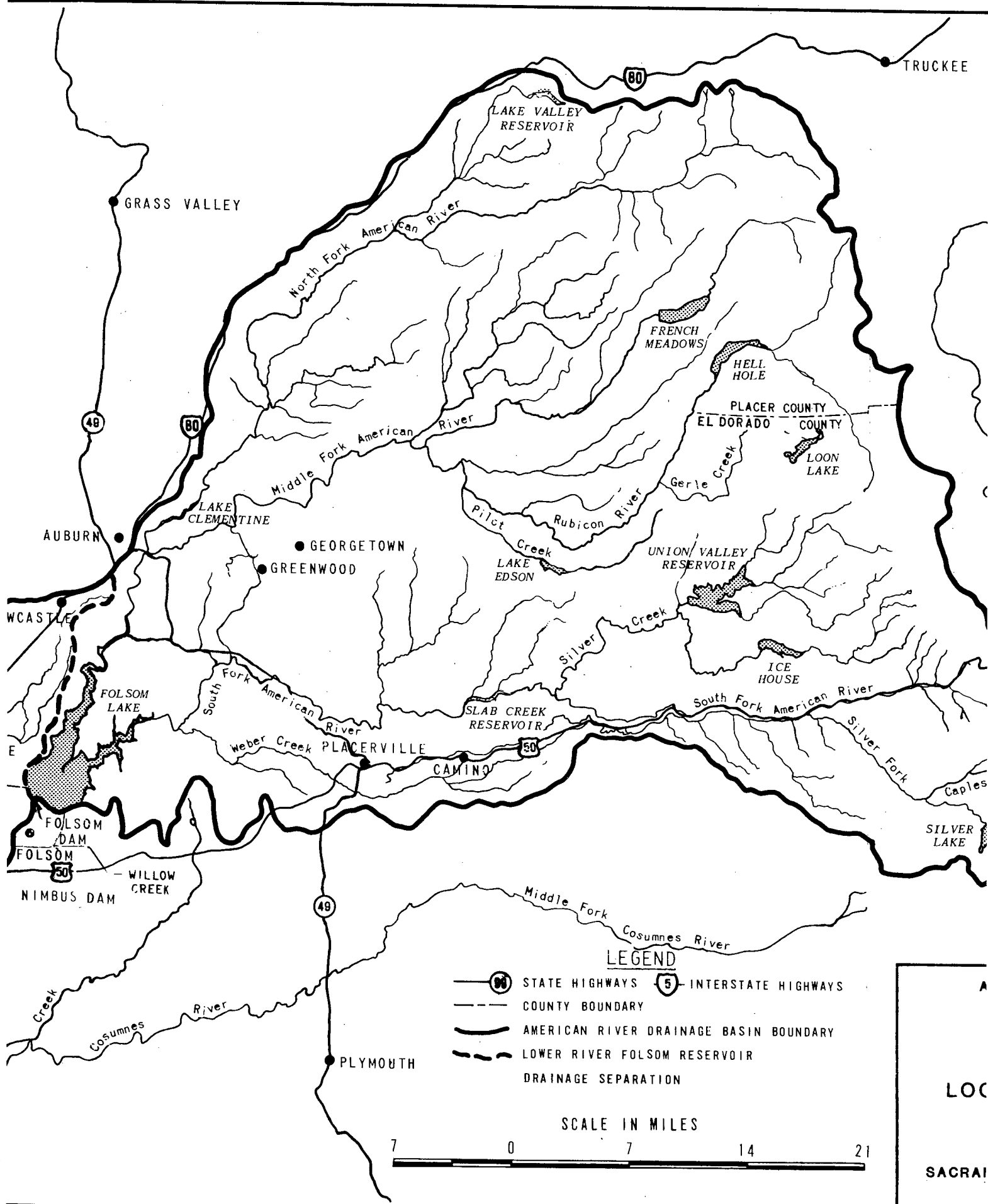
- The four tasks set forth in Engineering Regulation ER 1105-2-10 for the reconnaissance phase are complete.

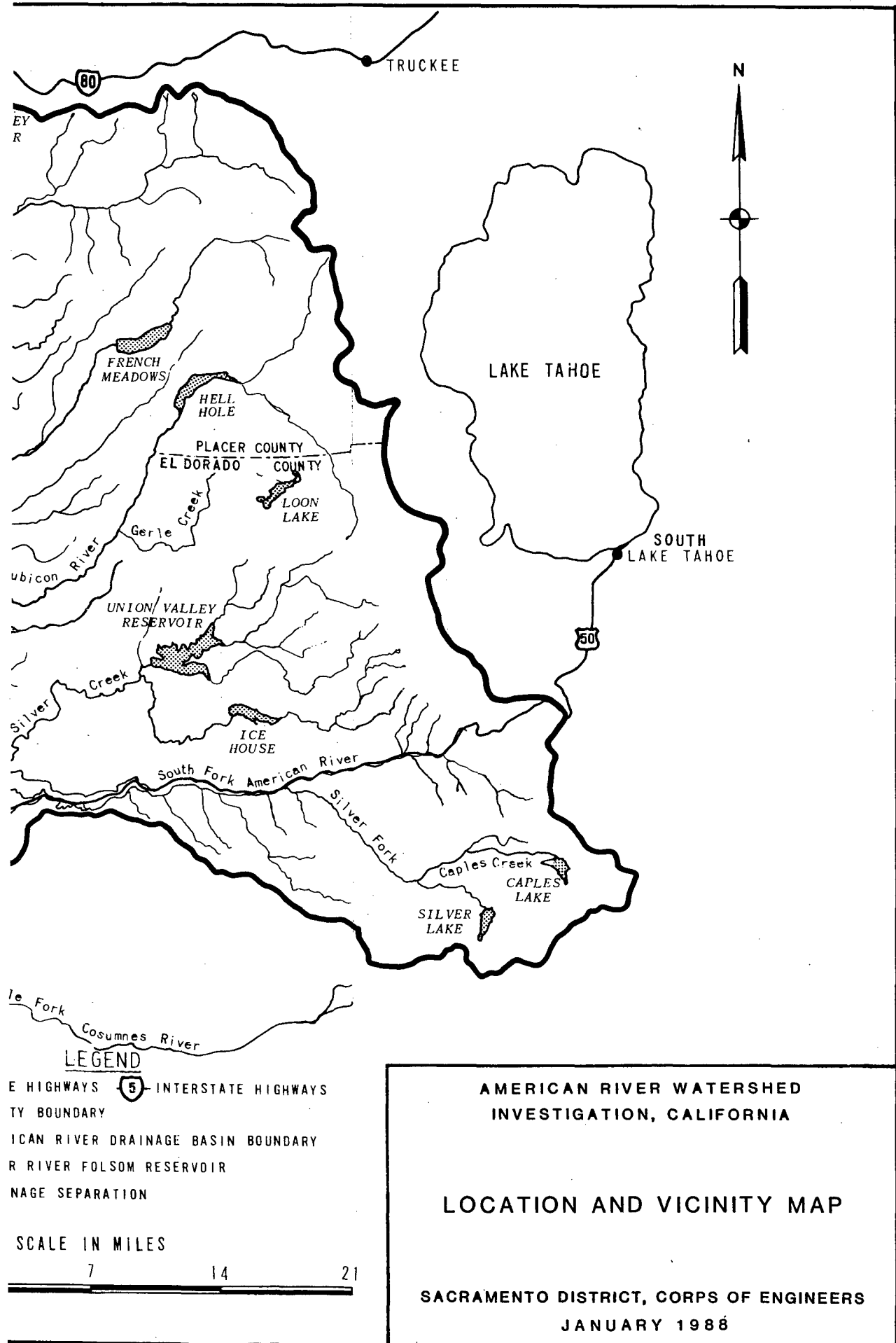
B. Recommendation. - I recommend that feasibility studies proceed for the mainstem American River and the Natomas area.

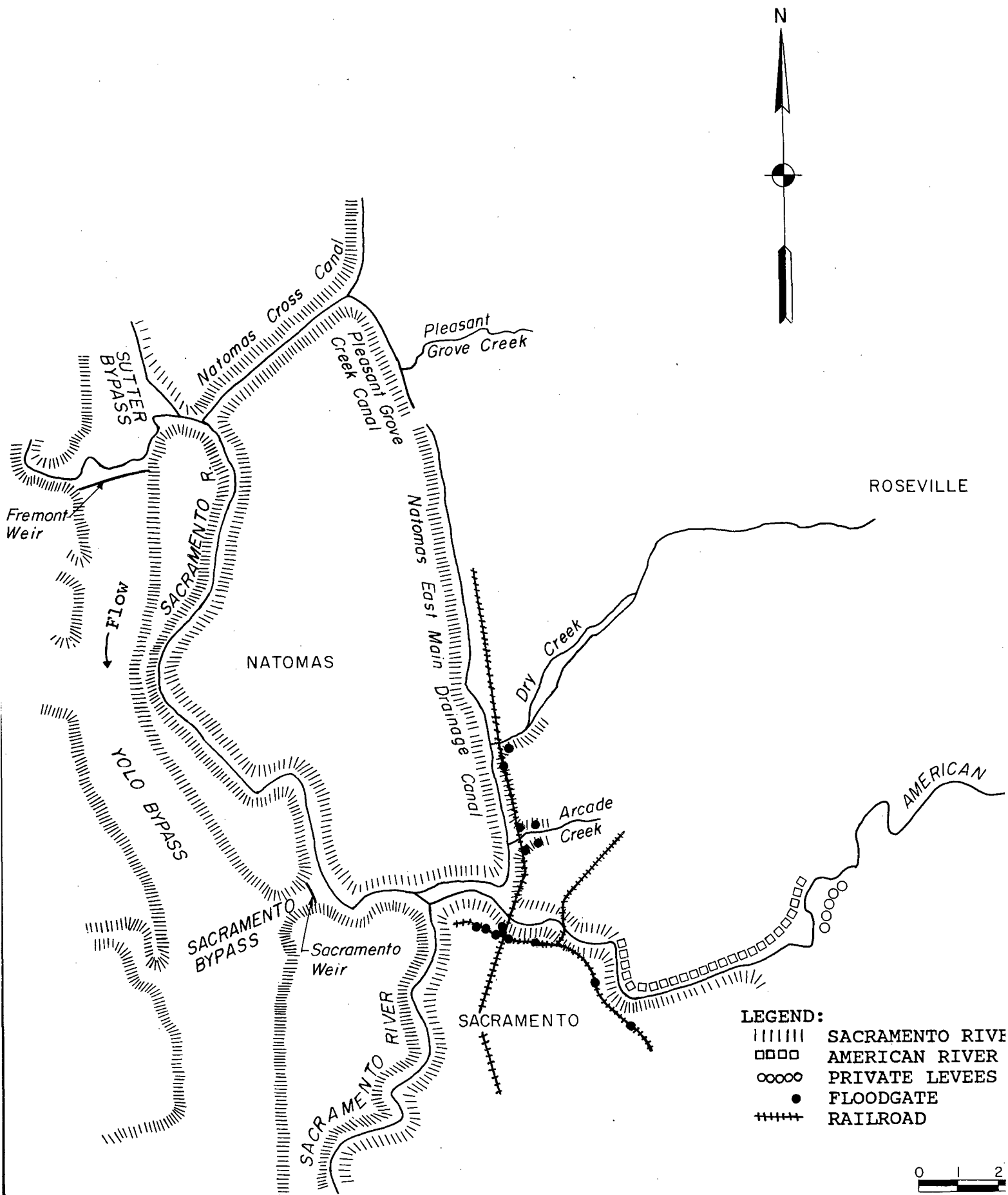


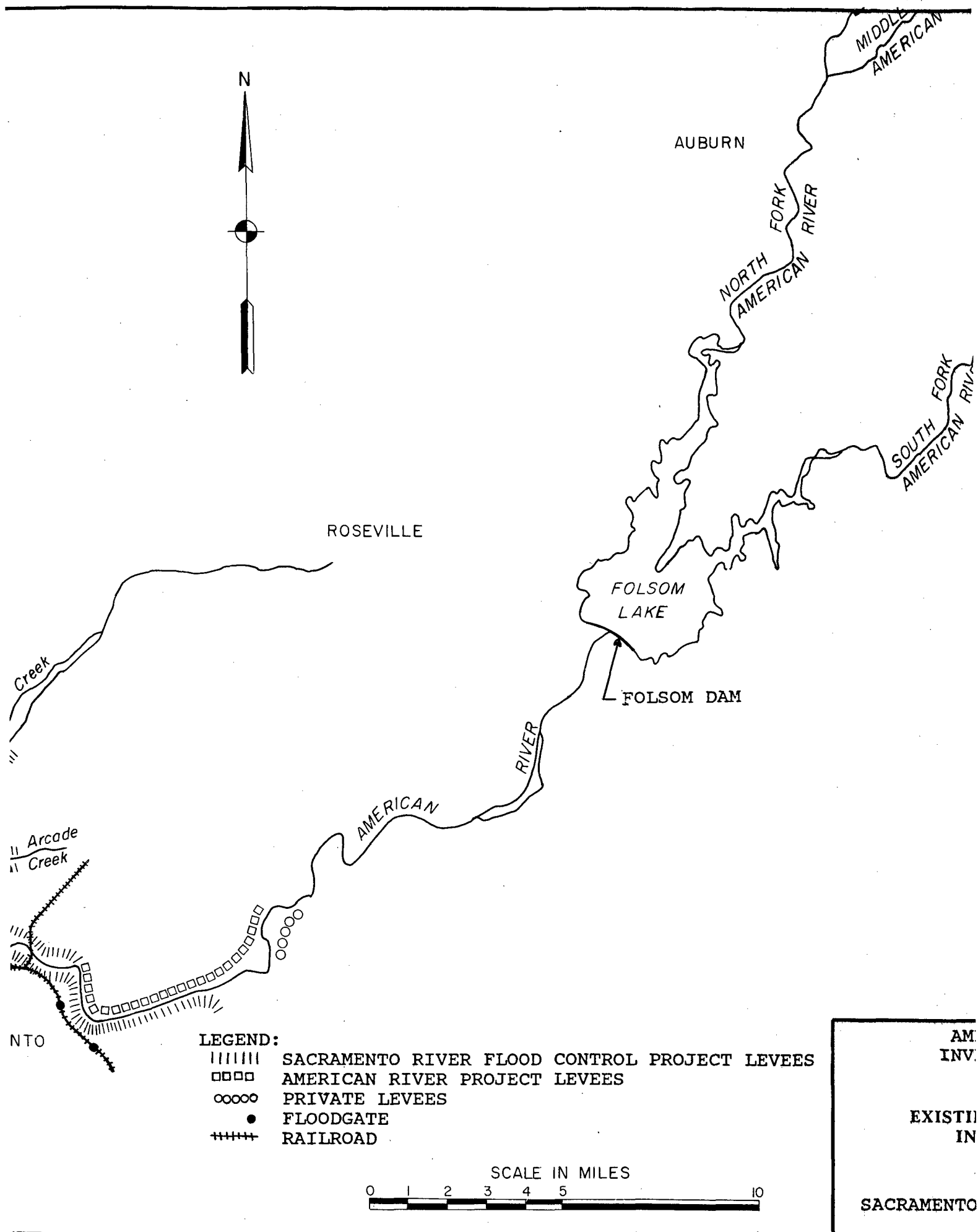
WAYNE J. SCHOLL
Colonel, Corps of Engineers
District Engineer

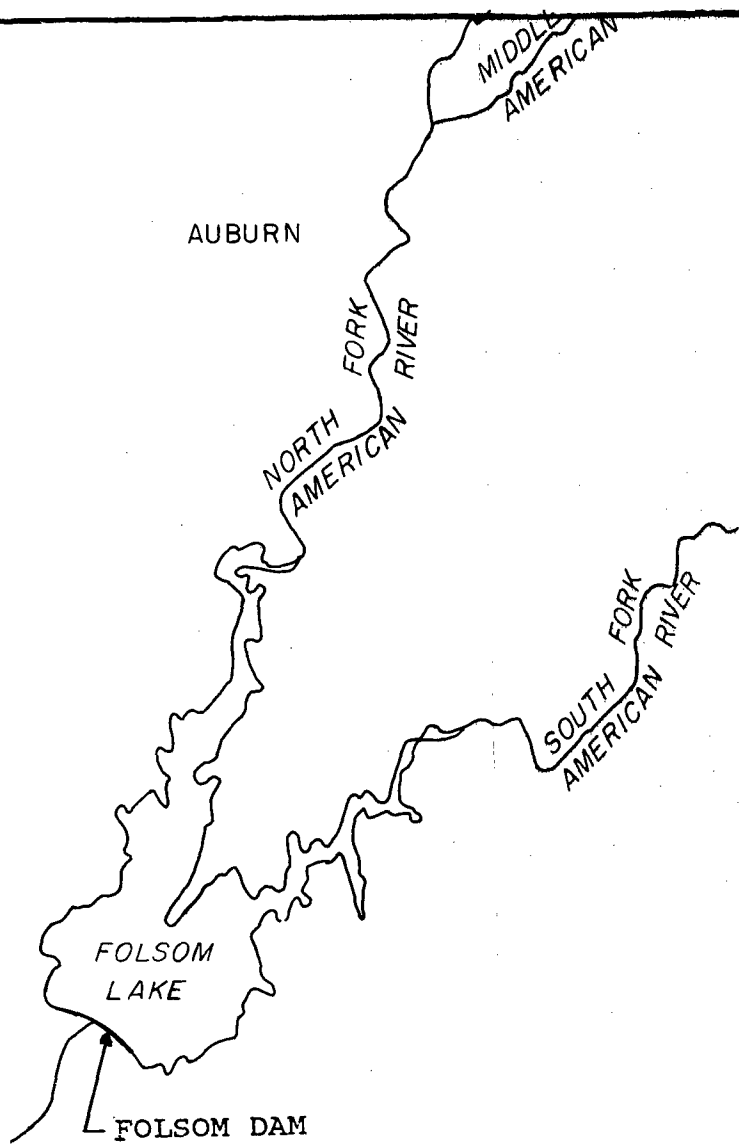












CONTROL PROJECT LEVEES
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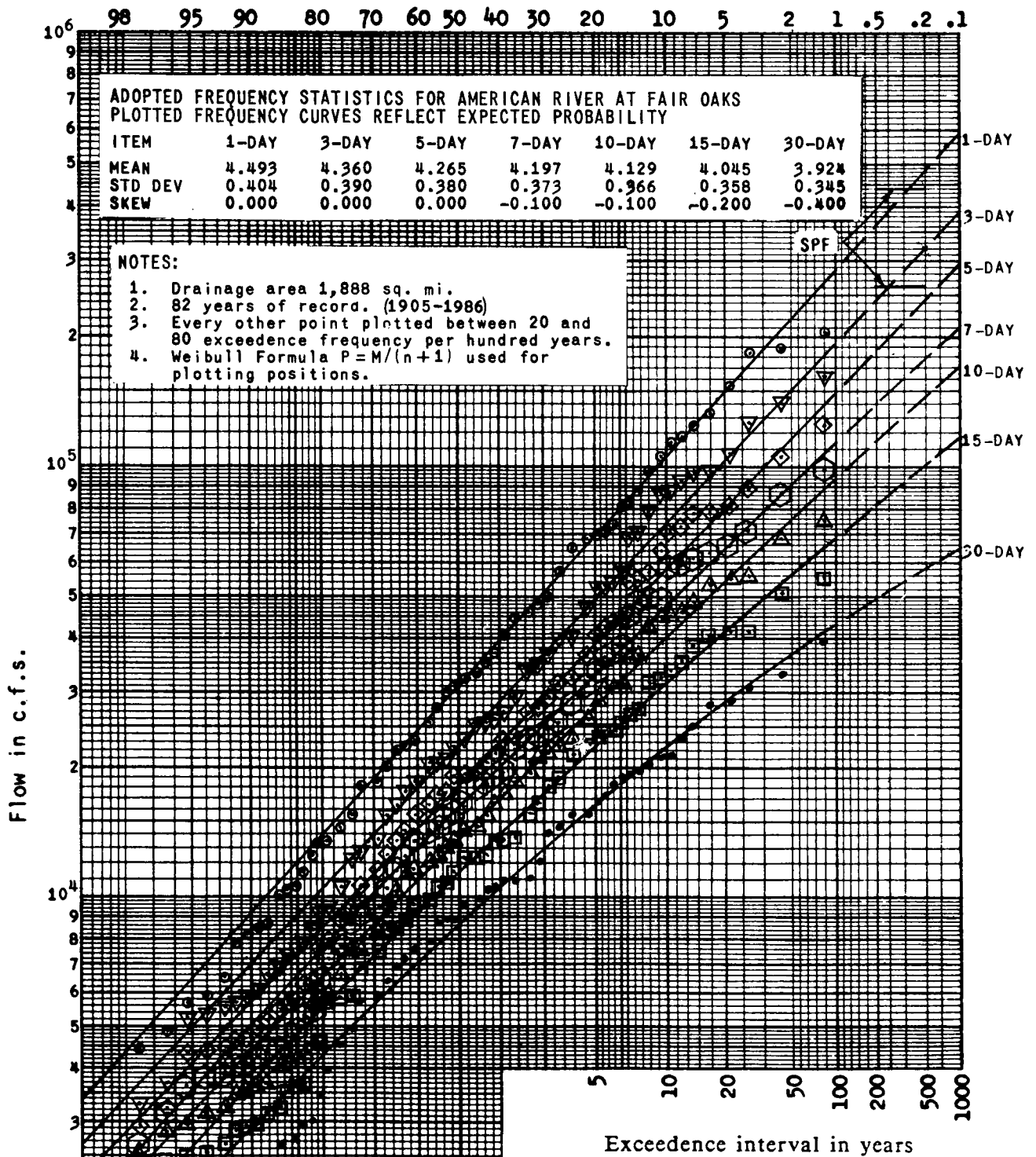


AMERICAN RIVER WATERSHED
INVESTIGATION, CALIFORNIA

EXISTING FLOOD CONTROL FEATURES
IN THE SACRAMENTO AREA

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
JANUARY 1988

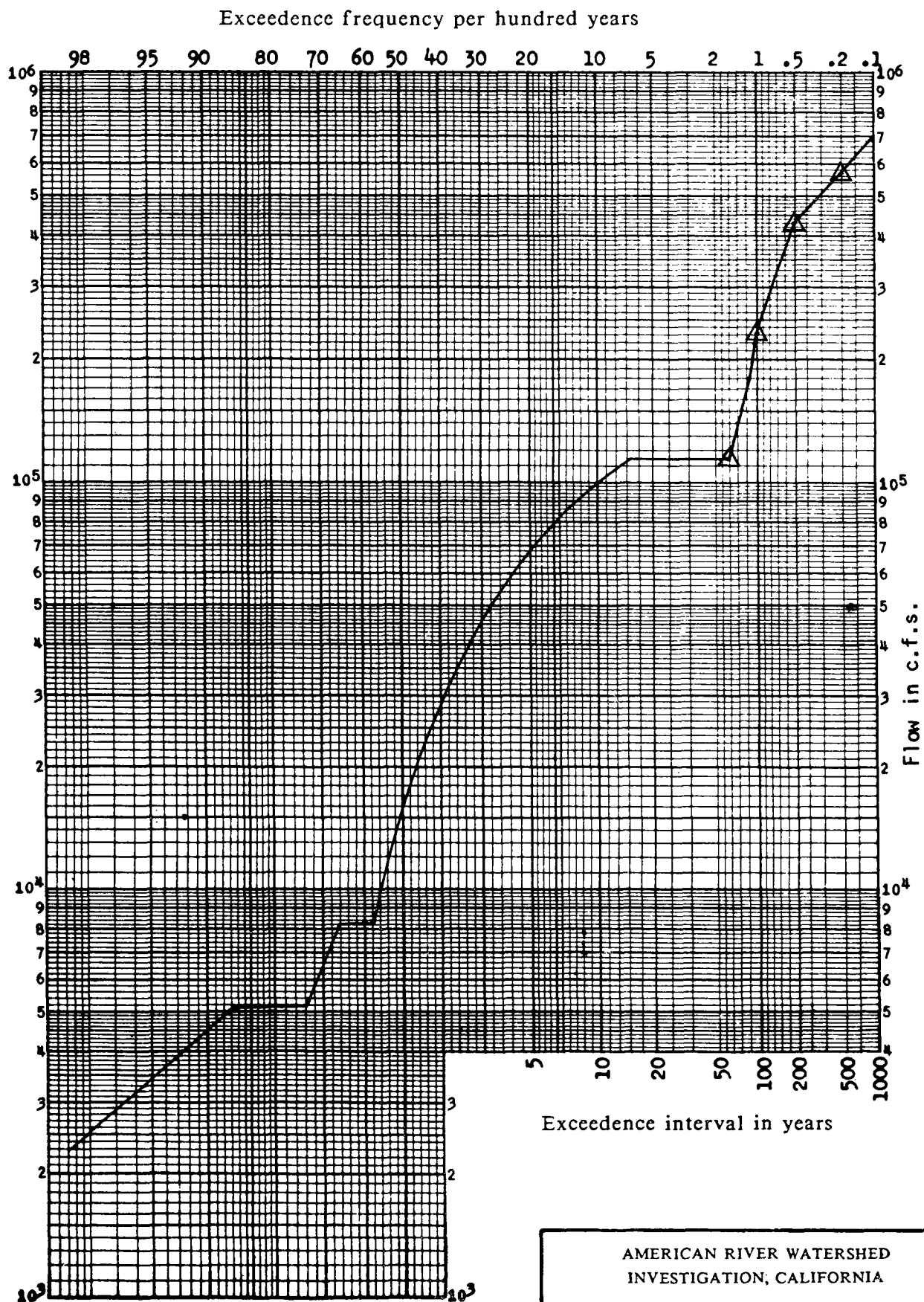
Exceedence frequency per hundred years



AMERICAN RIVER WATERSHED
 INVESTIGATION, CALIFORNIA

RAIN FLOOD FREQUENCY CURVES
 UNREGULATED CONDITIONS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
 JANUARY 1988



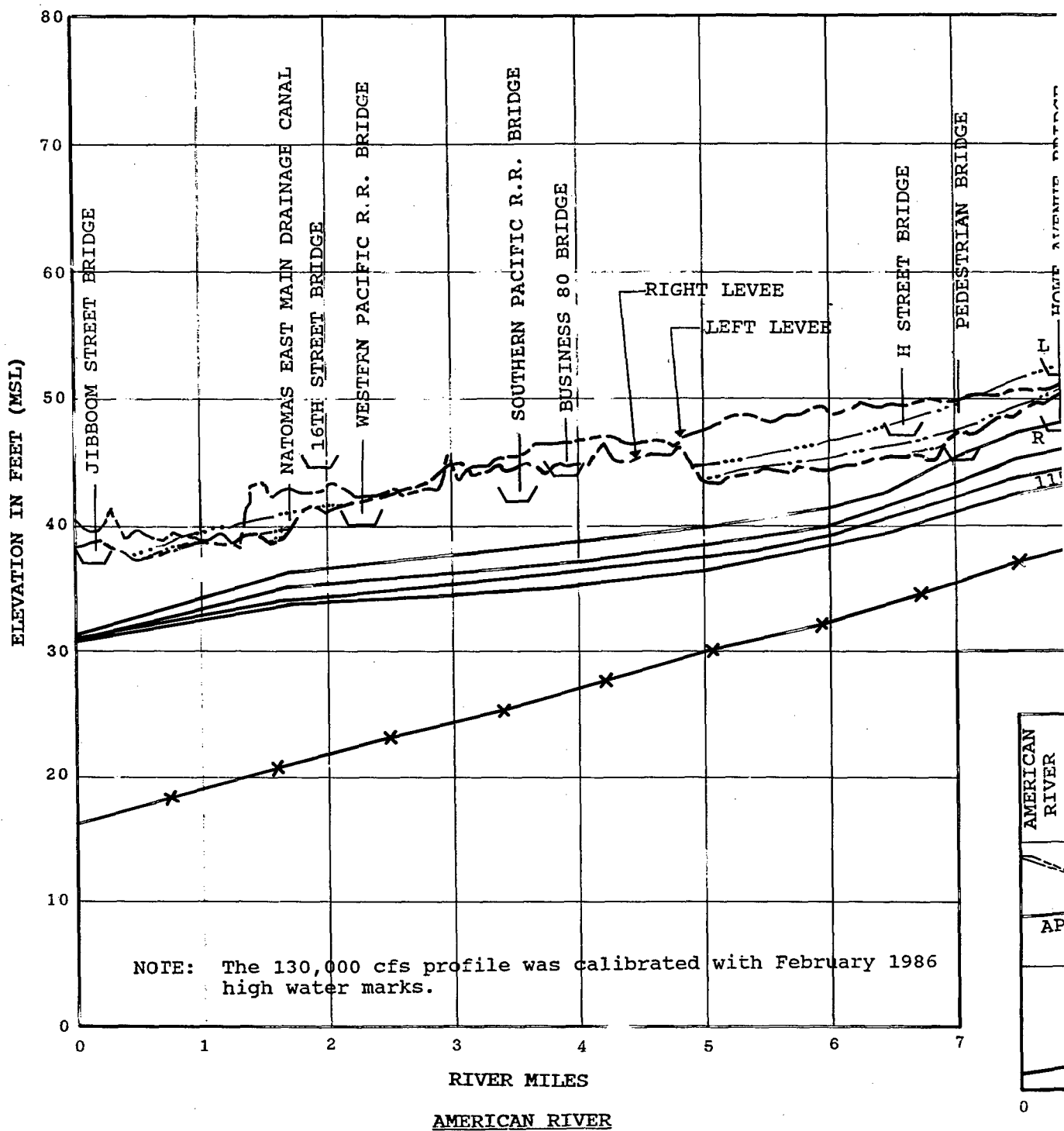
Notes:

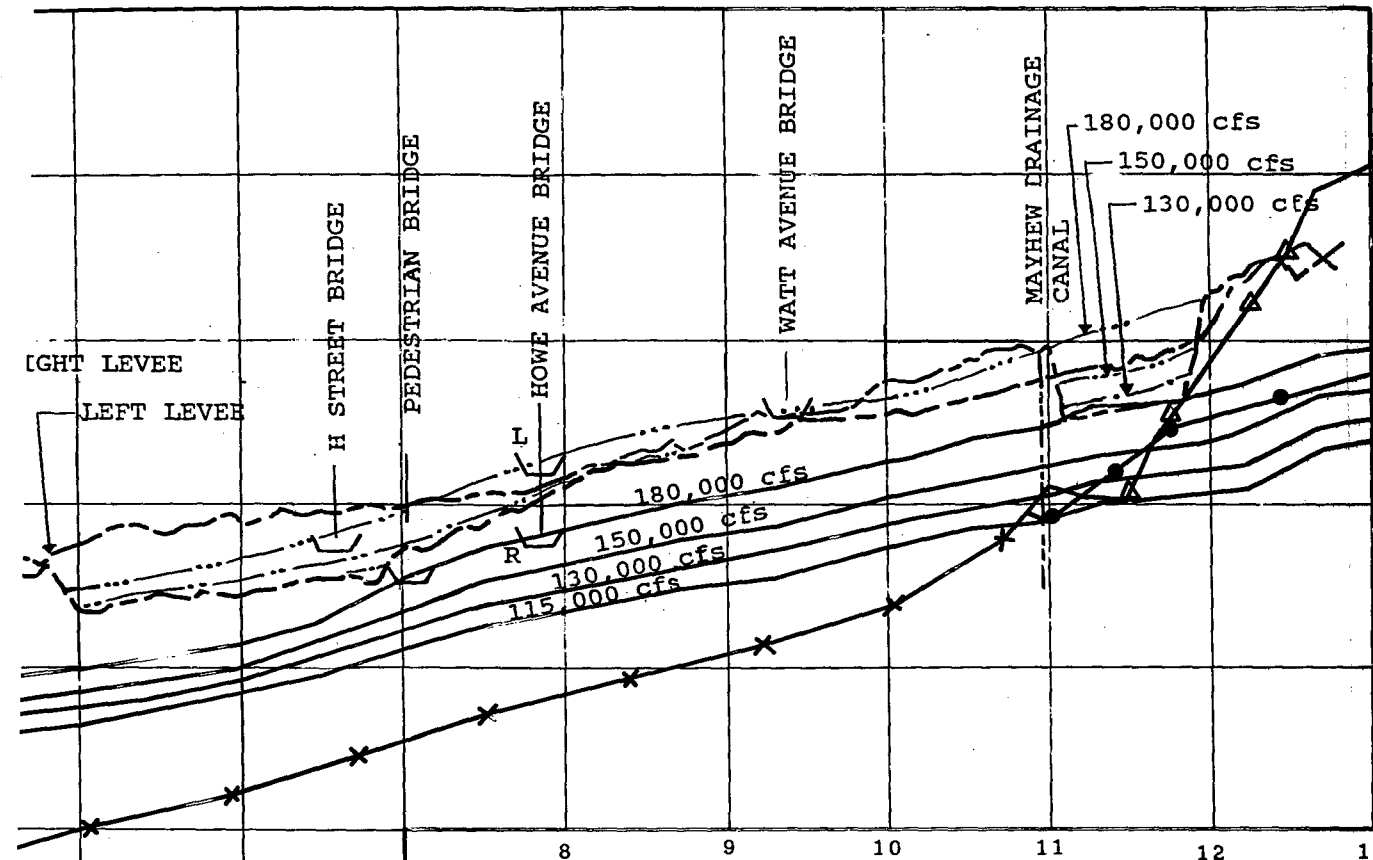
1. The project curves, to the 50 year event, reflects 32 years of record (1955-1986).
2. The remaining portion of the curve reflect the results of hypothetical flood routings as represented by the plotted points.
3. The hypothetical routings used the present authorized flood operation of Folsom Dam.

AMERICAN RIVER WATERSHED
INVESTIGATION, CALIFORNIA

PEAK FLOW-FREQUENCY CURVE
EXISTING CONDITIONS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
JANUARY 1988





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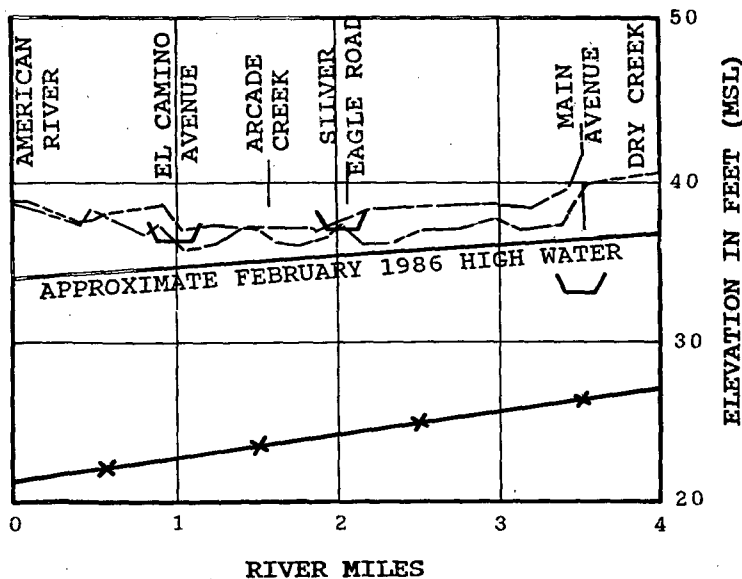
NOTE:

Levee Profile by DWR and

Water Surface East Main I surveyed hi City and Co

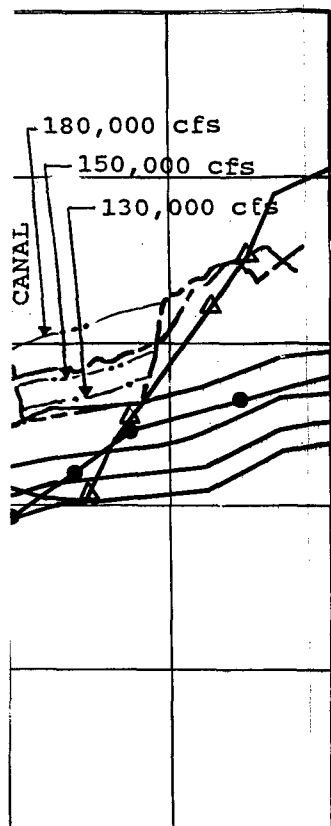
Water Surface River were information River Flood surveyed hi 1986 flood

ated with February 1986



NATOMAS EAST MAIN DRAINAGE CANAL

SACRAMENTO



1 12 13

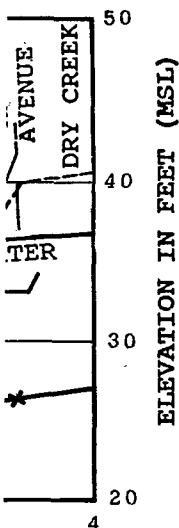
- LEGEND**
- River Stage for Indicated Flows
 - x — Average Natural Ground Adjacent to Levees
 - ● — Natural Ground Level Adjacent to River - Right Bank
 - ▲ — Natural Ground Level Adjacent to River - Left Bank
 - v — Bridge Soffit
 - Top of Levee - Right Bank
 - Top of Levee - Left Bank
 - . - Proposed Minimum Top of Levee for Channel Capacity of 130,000 cfs
 - . . Proposed Minimum Top of Levee for Channel Capacity of 150,000 cfs
 - . . Proposed Minimum Top of Levee for Channel Capacity of 180,000 cfs

NOTE:

Levee Profiles taken from surveys completed by DWR and the City of Sacramento in 1987.

Water Surface Profile for the Natomas East Main Drainage Canal obtained from surveyed high water marks taken by the City and County of Sacramento in 1986.

Water Surface Profiles on the American River were computed using cross sectional information from a report on the American River Floodplain, March 1, 1963, COE and surveyed high water marks from the February 1986 flood taken by DWR.

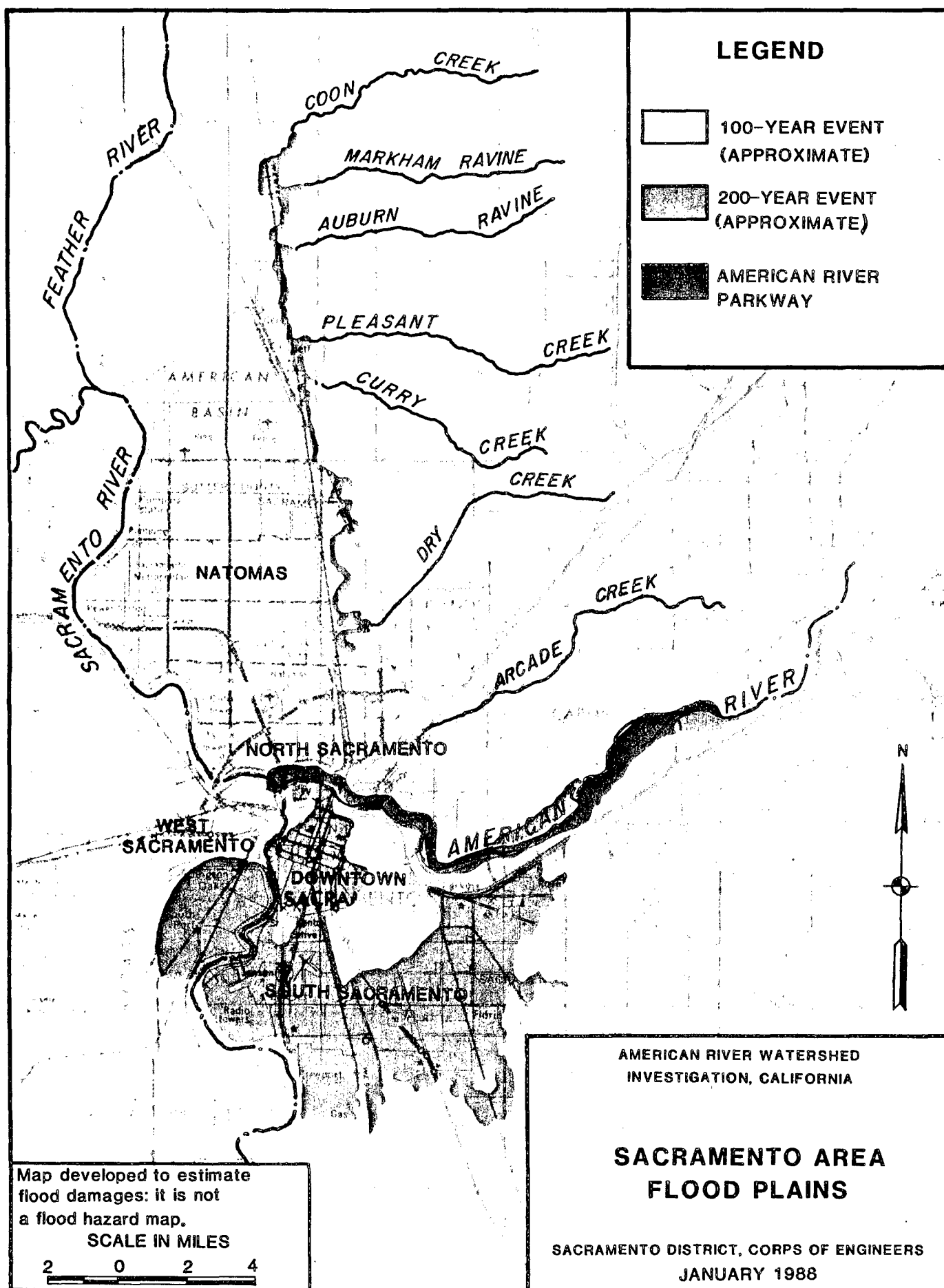


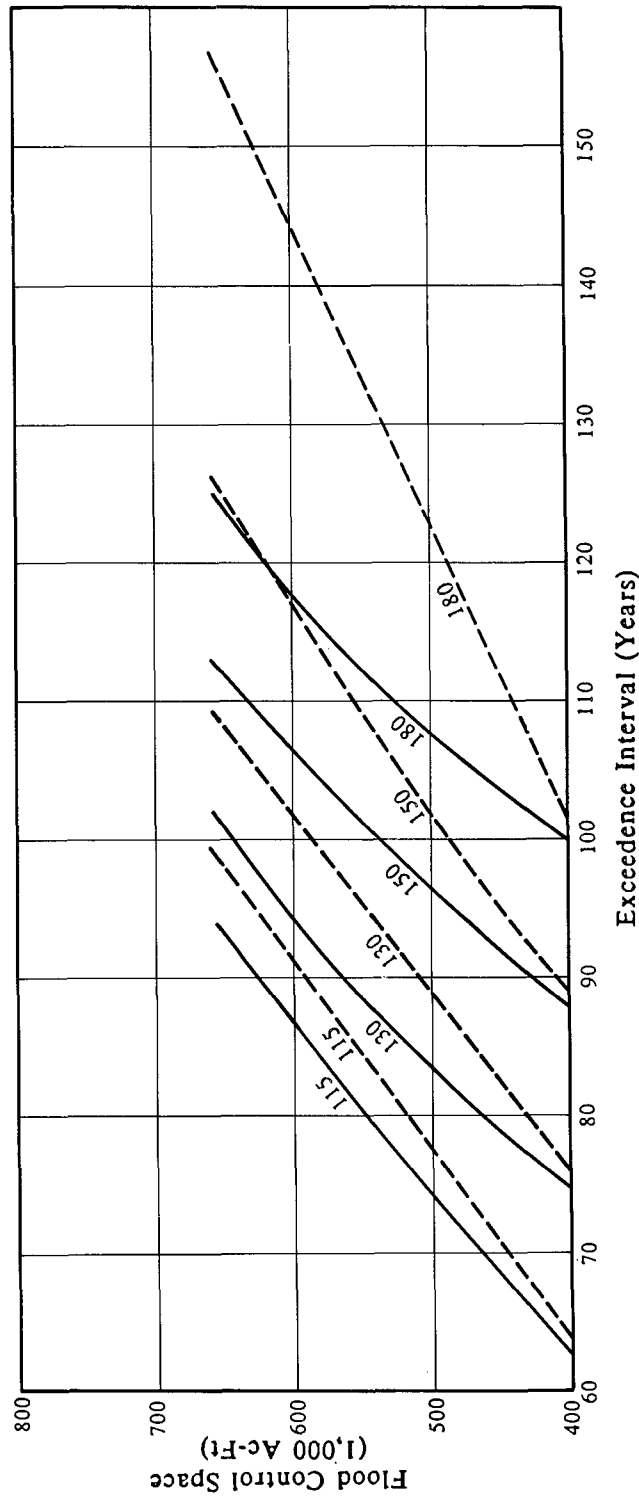
AMERICAN RIVER WATERSHED
INVESTIGATION, CALIFORNIA

LEVEES AND RIVER FLOW PROFILES

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
JANUARY 1988

PLATE 5





LEGEND:

- 115 Channel Capacity (1,000 cfs)
- Existing Spillway (Maximum Pool Elevation 470.0)
- Spillway lowered 15 feet (Maximum Pool Elevation 466.0)

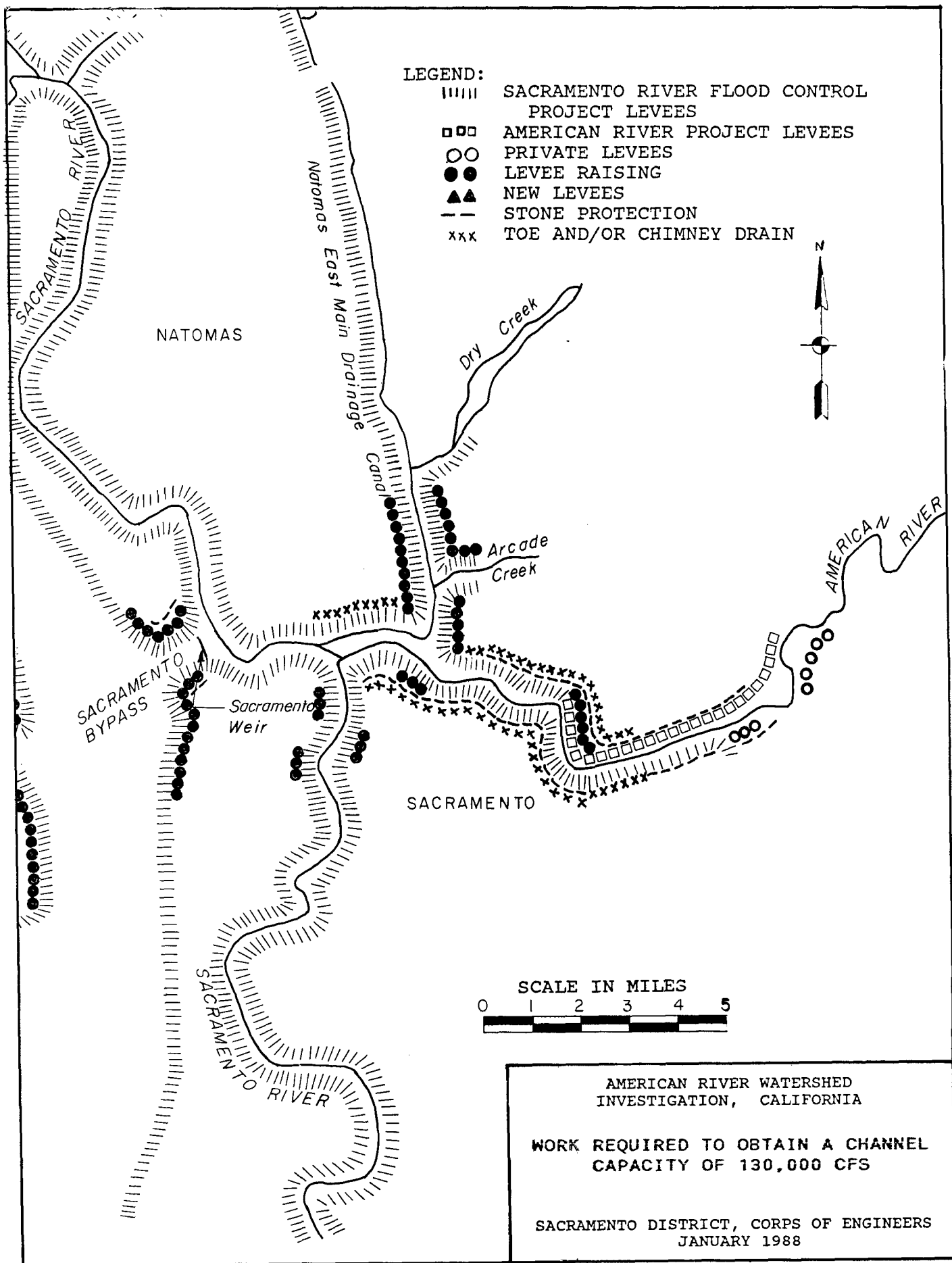
NOTE:

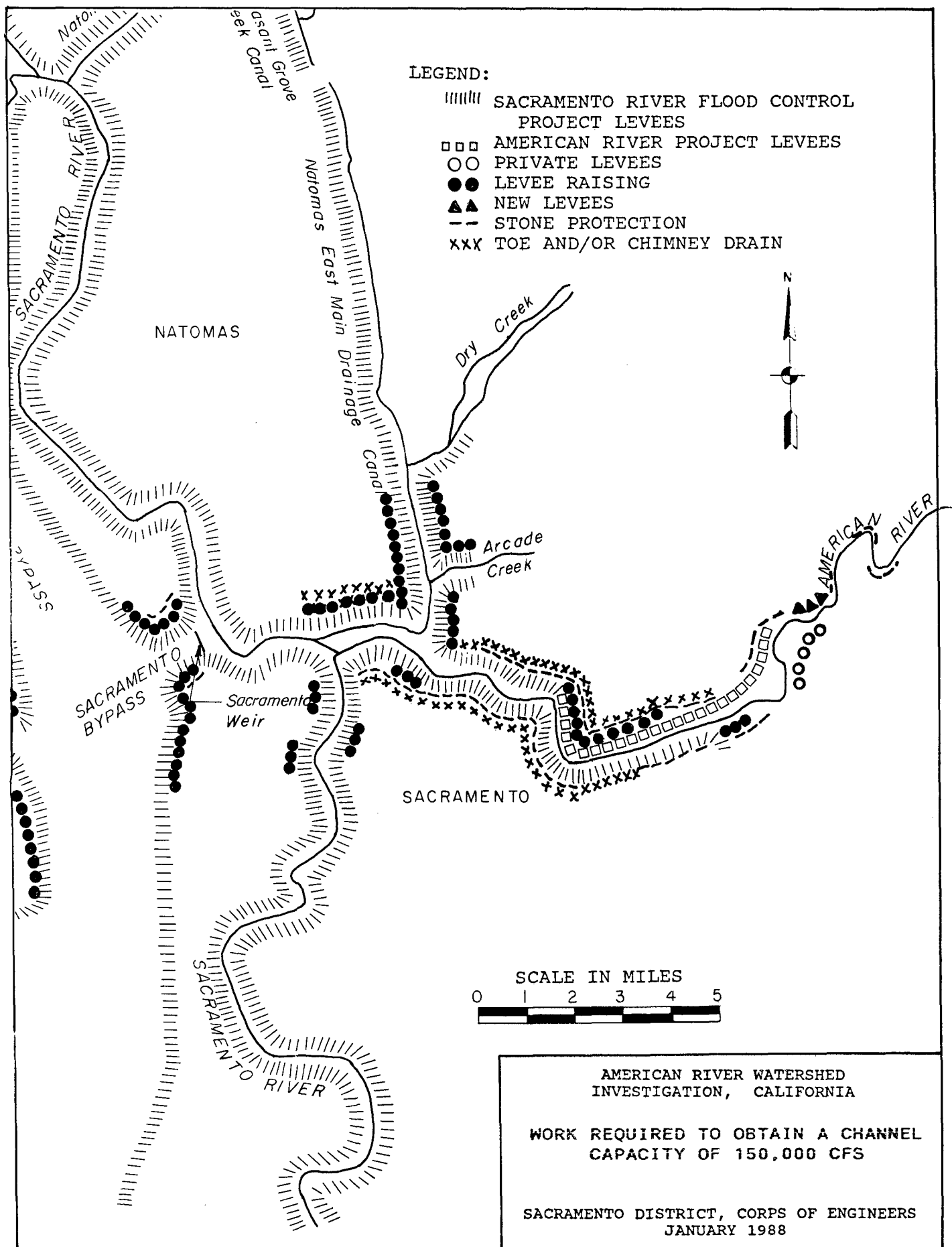
80,000 Ac-Ft initial encroachment into flood space;
 4 hr. delay on releases above starting release of 20,000 cfs;
 Outflow = inflow lagged 4 hrs. until channel capacity is reached;
 Maximum rate of change of release is 7,500 cfs/hr.;
 - 47,000 Ac-Ft of upstream storage credit for exceedence intervals ≥ 100 yrs.

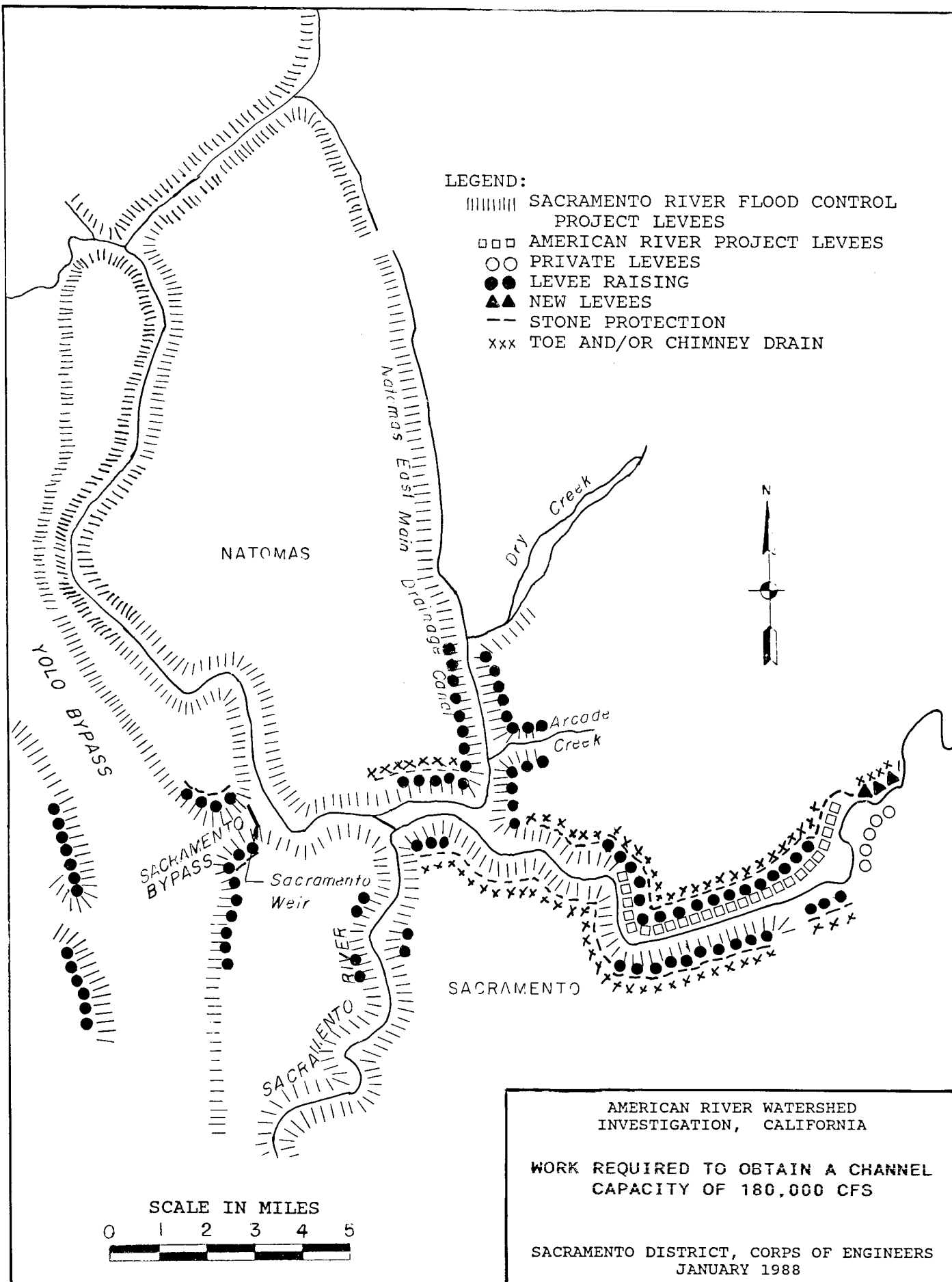
AMERICAN RIVER WATERSHED
 INVESTIGATION, CALIFORNIA

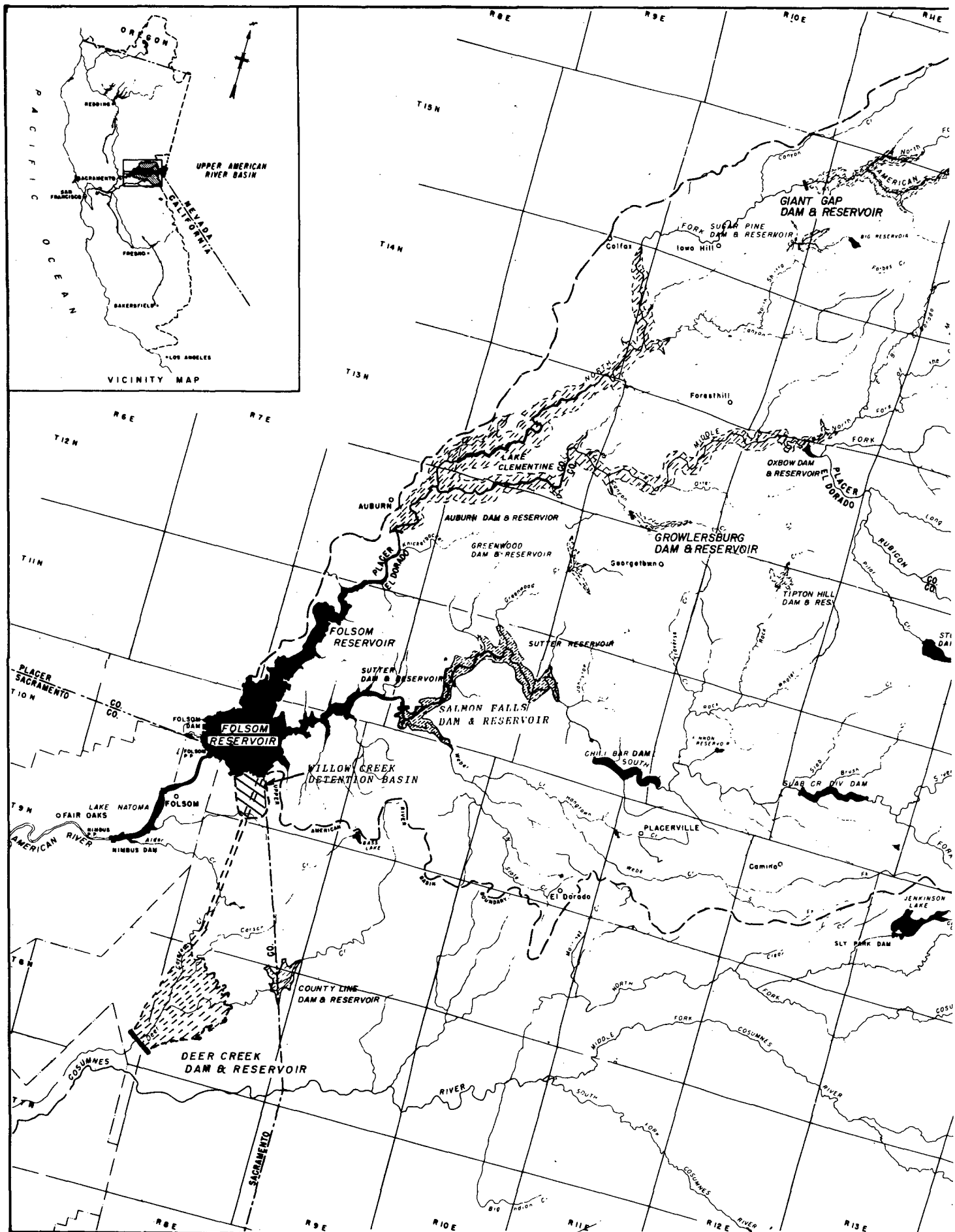
FOLSOM DAM OPERATION
 FOR
 DOWNSTREAM CONTROL

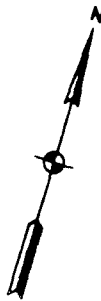
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
 JANUARY 1988











SOURCE:

U.S. Department of the Interior
Bureau of Reclamation

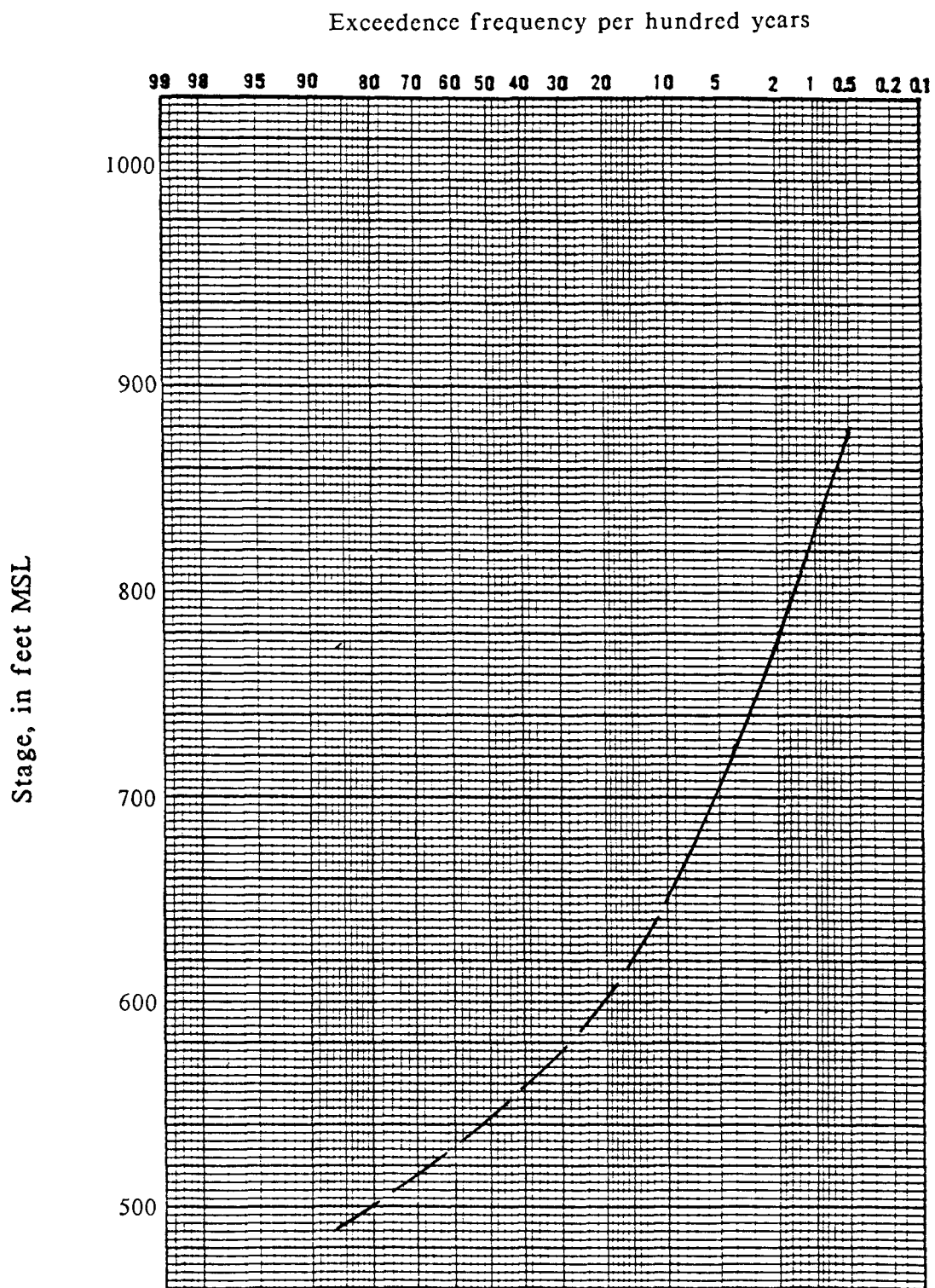
SCALE IN MILES

1 0 1 2 3 4 5

AMERICAN RIVER WATERSHED
INVESTIGATION, CALIFORNIA

AUBURN DAM AND RESERVOIR
AND VICINITY

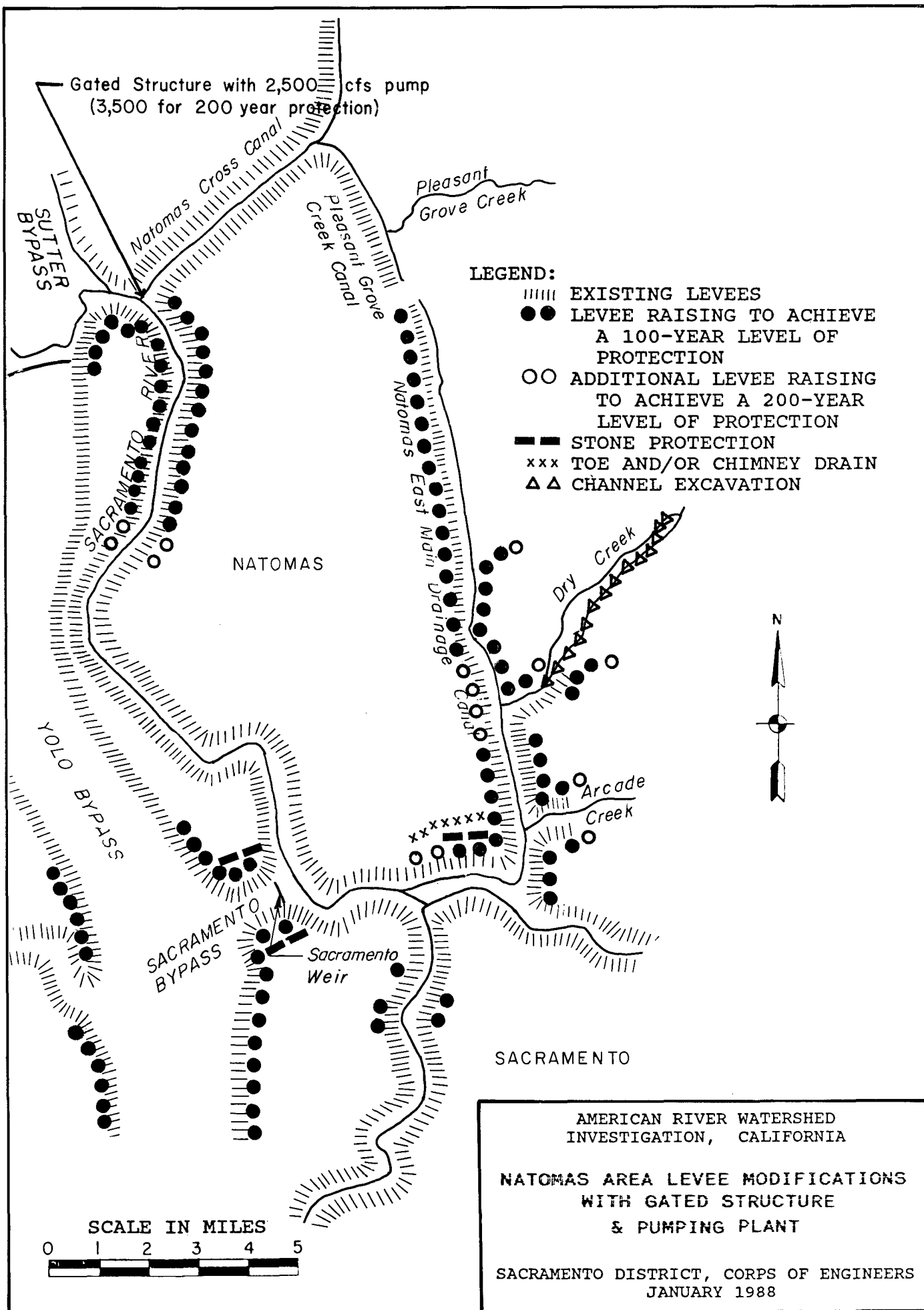
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
JANUARY 1988

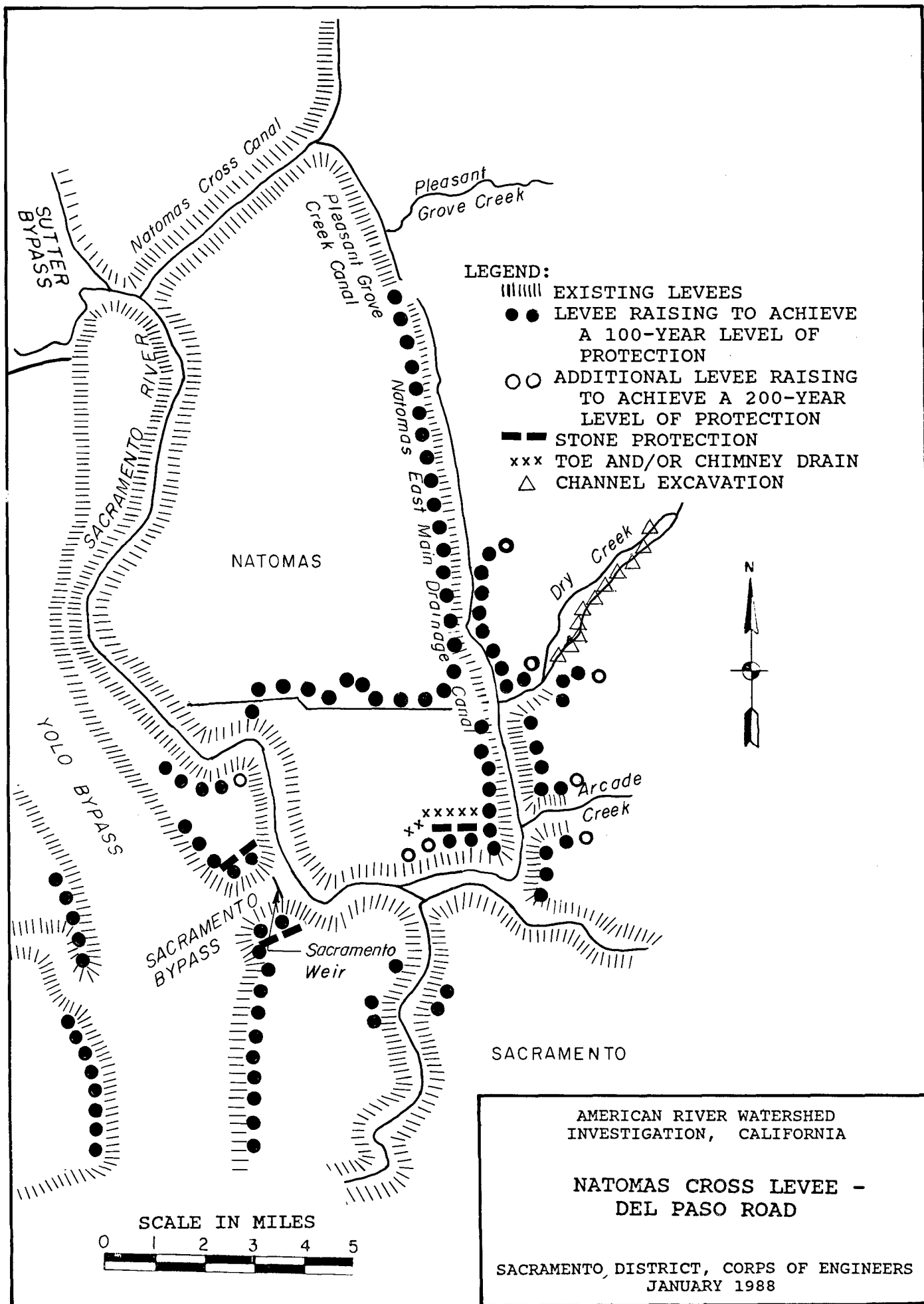


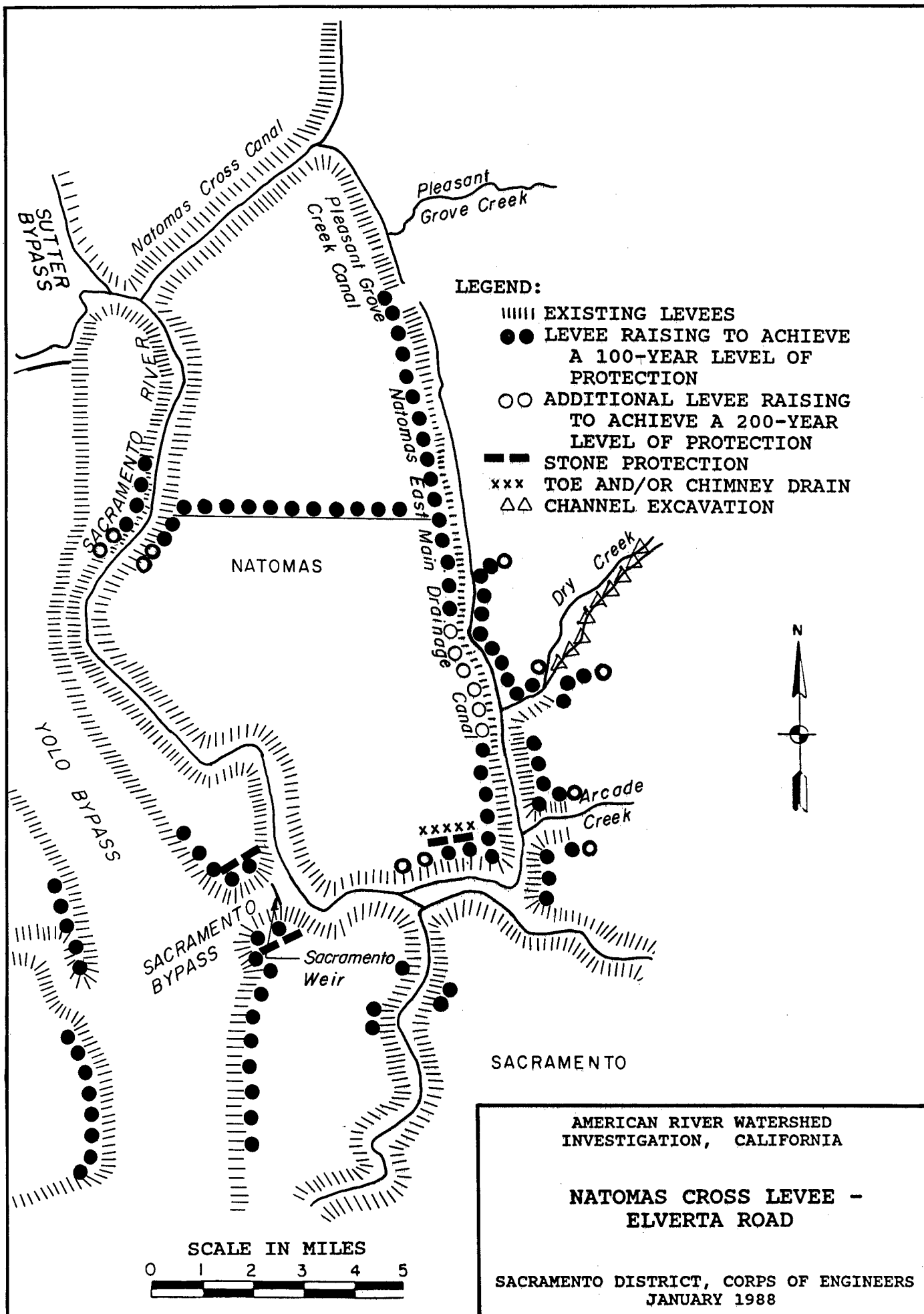
AMERICAN RIVER WATERSHED
INVESTIGATION, CALIFORNIA

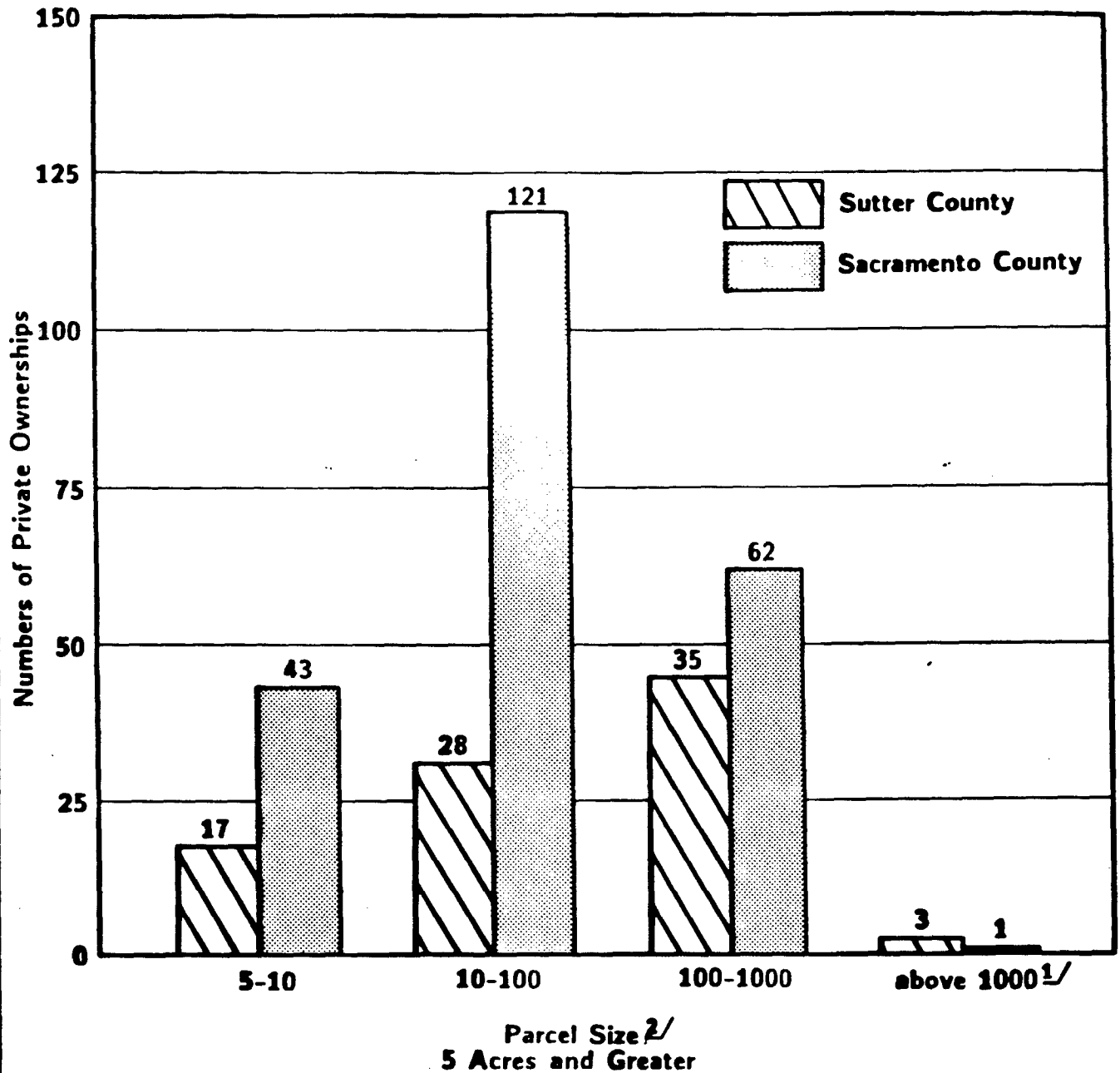
AUBURN RESERVOIR
STAGE-FREQUENCY RELATIONSHIPS
(30-FT LINED DIVERSION TUNNEL
(UNGATED))

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
JANUARY 1988









^{1/} Largest Private Ownership = 1,800 Acres
^{2/} Developed and Undeveloped
^{3/} Approximate

Natomas Area = 52,700 Acres
 Private Ownership Area = 46,500 Acres
 5 Acres and Greater = 40,700 Acres
 5 Acres and Less = 5,800 Acres ^{3/}
 Public Ownership Area = 6,200 Acres

AMERICAN RIVER WATERSHED
INVESTIGATION, CALIFORNIA

NATOMAS LAND OWNERSHIP

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
JANUARY 1988

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APPENDIX A
PERTINENT DATA
ON
FOLSOM DAM

Folsom Dam and Reservoir, American River, California

PERTINENT DATA

General

<u>Drainage areas</u>	
American River at Folsom Dam	1875 sq. miles
S Fk American River at Lotus	678 sq. miles
N Fk American River near Auburn	619 sq. miles
N Fk American River at North Fork Dam	343 sq. miles
Webber Creek near Salmon Falls	100 sq. miles
American River at Fair Oaks	1921 sq. miles
American River at W St Bridge	1969 sq. miles
<u>Discharges</u>	
Mean annual (1905-32)	2,748,000 ac-ft
Minimum of record (16 Aug 1924)	4 cfs
Maximum of record (23 Dec 1955)	219,000 cfs
Maximum historical (10 Jan 1862)	280,000 cfs
Spillway design inflow (peak)	615,000 cfs
<u>Estimated tailwater elevations</u>	
For flow of 3930 cfs (mean annual)	125 feet
For flow of 115,000 cfs (design outflow)	175 feet
For flow of 567,000 cfs (spillway design)	238 feet

Main Dam (concrete gravity)

Elevation, top of parapet	484.0 feet
Freeboard above spillway flood pool	8.6 feet
Elevation, crown of roadway	480.5 feet
Maximum height, foundation to roadway crown	340.0 feet
Length of crest (spillway and abutment)	1400 feet
Width of crest at roadway	36.25 feet
Width of roadway, curb to curb	30.0 feet
Excavation	960,000 cu-yd
Mass concrete	1,200,000 cu-yd

Wing Dams (rolled earth)

Crest elevation	480.5 feet
Freeboard above spillway design pool	5.1 feet
Crest width	30 feet
Roadway width, left wing dam	24 feet
Right wing dam	16 feet
Maximum height, left wing dam	145 feet
Right wing dam	145 feet
Length of crest, left wing dam	2100 feet
Right wing dam	6700 feet
<u>Side slopes</u>	
Upstream above elev 450	1 on 2.25
Elev 450 to 427	1 on 3.25
Below elev 427	1 on 3.75
Downstream	1 on 2
Total excavation	290,000 cu-yd
Total volume of embankment	7,810,000 cu-yd

Dikes (rolled earth)

Crest elevation	480.5 ft
Freeboard above spillway pool	5.1 feet
Width of crest	20 feet
<u>Length of crests</u>	
Dike 1	2060 feet
Dike 2	1800 feet
Dike 3	1395 feet
Dike 4	1450 feet
Dike 5	1915 feet
Dike 6	1460 feet
Dike 7	890 feet
Dike 8	740 feet
<u>Maximum heights</u>	
Dike 1	25 feet
Dike 2	15 feet
Dike 3	10 feet
Dike 4	30 feet
Dike 5	100 feet
Dike 6	40 feet
Dike 7	35 feet
Dike 8	15 feet
<u>Side slopes</u>	
Upstream, Crest to elev 466	1 on 2.25
Below elev 466	1 on 3.25
Downstream	1 on 2.25
Total excavation	160,000 cu-yd
Total volume of embankment	1,200,000 cu-yd

Reservoir 7

<u>Elevation</u>	
Minimum power pool	327.0 feet
Flood control pool	427.0 feet
Gross pool	466.0 feet
Spillway design flood pool	475.4 feet
Guide taking line	466.0 feet elev. +300 ft landward
<u>Area</u>	
Minimum power pool	2030 acres
Flood control pool	9040 acres
Gross pool	11,450 acres
Spillway flood pool	11,930 acres
Guide taking line	12,000 acres
Proposed acquisition line	19,500 acres
<u>Storage capacity</u>	
Minimum power pool	90,000 ac-ft
Flood control pool	610,000 ac-ft
Gross pool	1,010,000 ac-ft
Spillway flood pool	1,120,000 ac-ft

Spillway (gated ogee)

<u>Crest length</u>	
Gross	392 feet
Net	336 feet
Crest elevation	418.0 feet
Design head	50 feet
Spillway flood head	57.4 feet
Capacity	567,000 cfs
Crest gates (tainter), number and size	3 - 42 x 53 feet
Seat elevation	417.16 feet
Top elevation when closed	3 - 471.0 ft 5 - 468.0 ft

Outlets

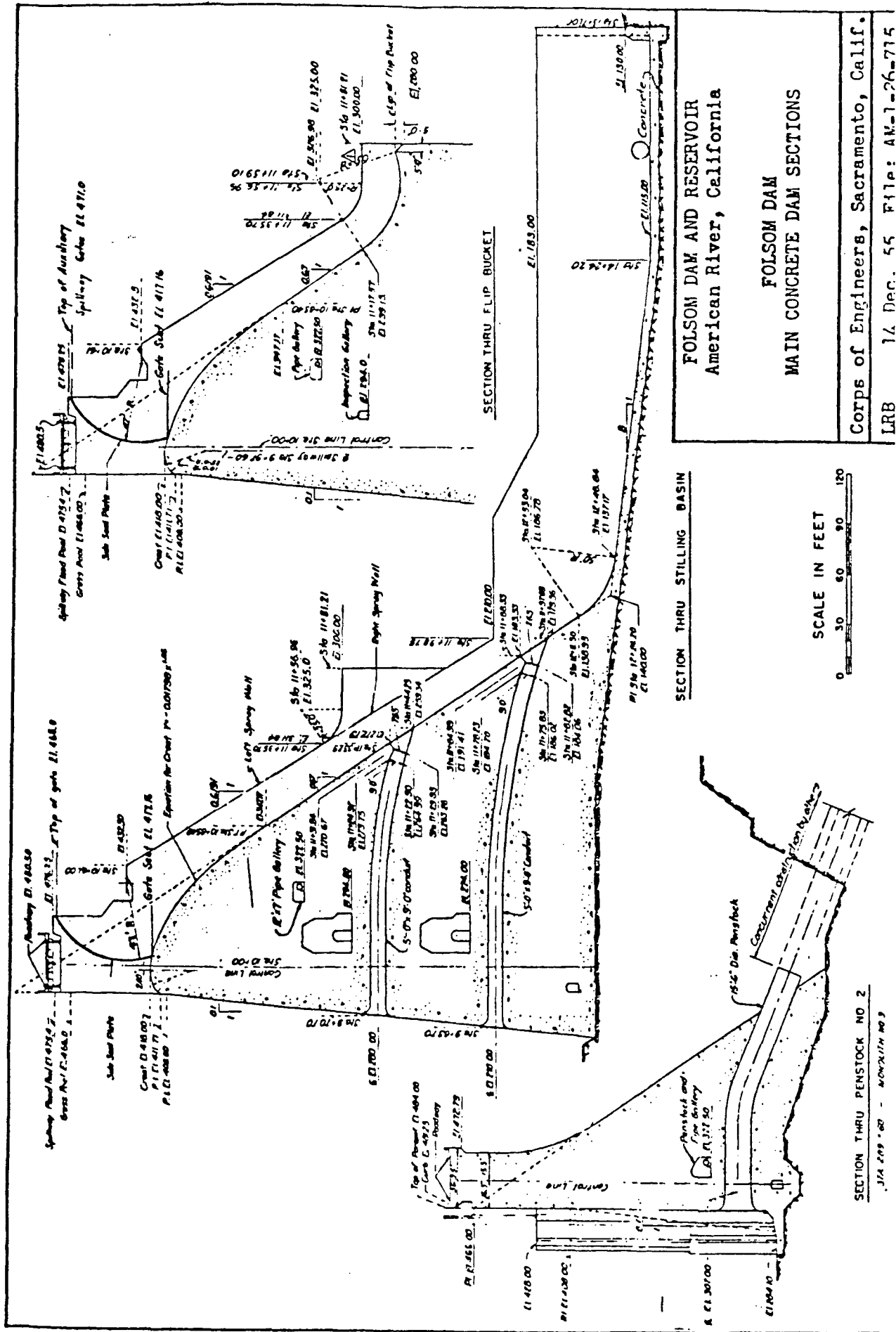
<u>River outlets, 2 tiers</u>	
<u>Each tier:</u>	
Outlets, number and size	4 - 5 x 9 feet
Service gates (hydraulic slide)	4 - 5 x 9 feet
Emergency gates (hydraulic slide)	4 - 5 x 9 feet
Intake elevation, invert, lower tier	205.5 feet
upper tier	275.5 feet
Length of conduit, lower tier	229.31 feet
upper tier	169.04 feet
Fixed-wheel gate (for all conduits)	1 - 8.33x15.07 ft
<u>Pumping outlet</u>	
Number and size	1 - 84" diameter
Intake elevation, centerline	317 ft
Gate valve	1 - 60"
<u>Total capacity</u>	
With water surface at elev 290.0	13,100 cfs
With water surface at elev 427.0	28,600 cfs

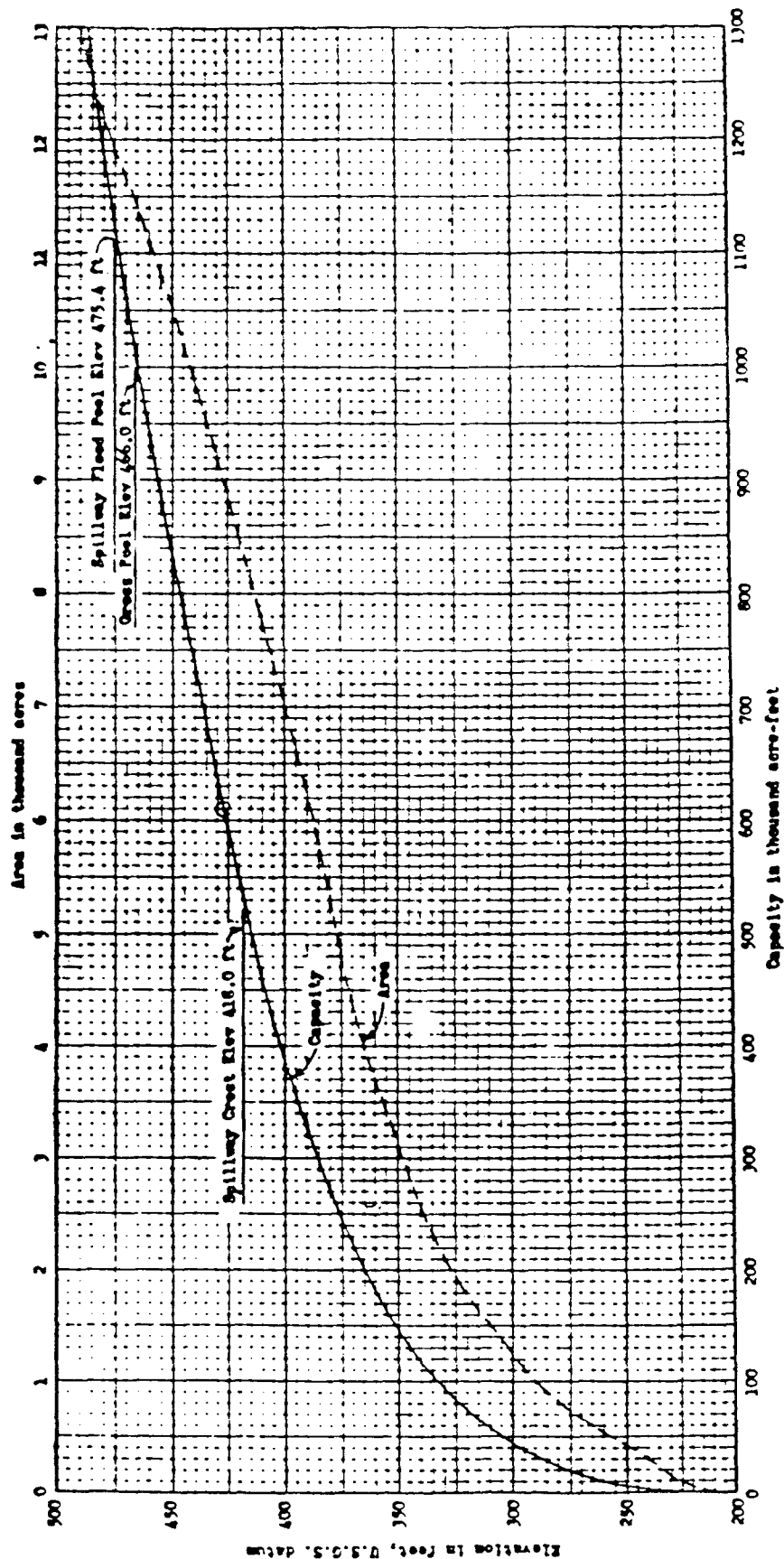
Power Penstock (steel-lined)

Number and size	3 - 15.5 ft dia
Intake elevation, centerline	307 feet
Fixed wheel gates	3 - 12.78 x 24.32 ft
Generator capacity, 3 units	160,000 Kw.

Mormon Island Dam (rolled earth)

Crest elevation	480.5 ft
Freeboard above spillway flood pool	5.1 feet
Crest width	30 feet
Maximum height	110 feet
Crest length	4820 feet
<u>Side slopes</u>	
Upstream, Crest to elev 466	1 on 2
Elev 466 to elev 427	1 on 3
Below elev 427	1 on 4.5
Downstream, Crest to elev 466	1 on 2
Elev 466 to elev 427	1 on 2.5
Below elev 427	1 on 3.5
<u>Undredged valley and abutment section</u>	
Upstream slope	1 on 2
Downstream slope	1 on 2
Total excavation	660,000 cu-yd
Total volume of embankment	3,820,000 cu-yd





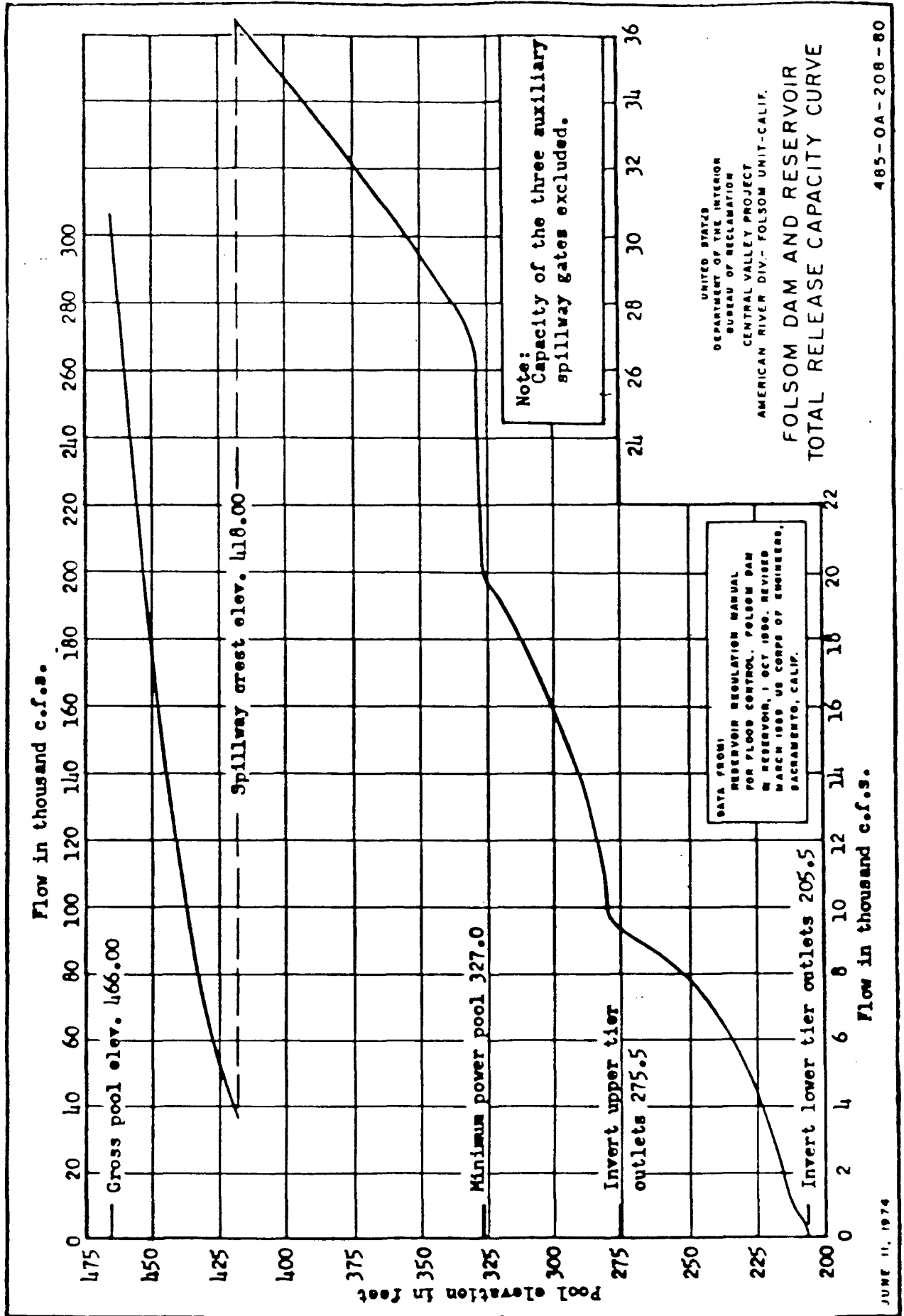
DATA FROM:
RESERVOIR REGULATION MANUAL
FOR FLOOD CONTROL, FOLSOM DAM
@ RESERVOIR, 1 OCT 1960, REVISED
MARCH 1960 BY CORPS OF ENGINEERS,
SACRAMENTO, CALIF.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT
AMERICAN RIVER DIV.- FOLSOM UNIT-CALIF.

FOLSOM DAM AND RESERVOIR AREA AND CAPACITY CURVES

JUNE 11, 1974

485-0A-208-81



NOTES

The objective of the Flood Control Program is to provide an increased degree of protection to the Lower American River during the development of a revised flood control operational plan for the American River Basin.

Flood Control Reservoirs are the primary flood storage facilities required under present authorization when water is stored in the state reservoir releases must be in accordance with requirements of this diagram.

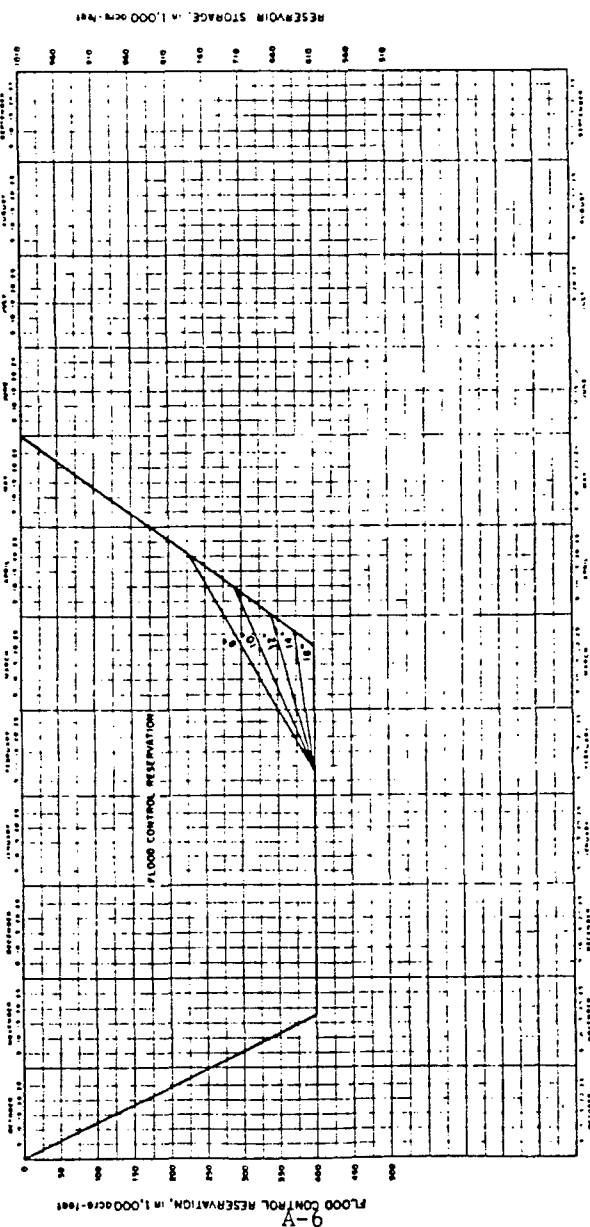
USE OF DIAGRAM

Run flood parameters defining the flood control space reservation on any given day and are computed daily from the highest accumulation of seasonal basin mean precipitation by adding the current day's precipitation in inches to 9% of the parameter computed the preceding day.

Flood control releases are required by the accompanying Emergency Spillway Release Program water stored within the Flood Control Reservoir defined herein shall be released as rapidly as possible subject to the following schedule.

- a. Required Flood Control Release:
 1. Maximum inflow up to 115,000 cfs but not less than 20,000 cfs when inflows are increased.
 2. Release a flood not increased more than 15,000 cfs or decreased more than 10,000 cfs during any 2 hour period.

Maximum inflow is the greatest inflow since storage entered into Flood Control Reservoir.



FOLSOM DAM AND LAKE
American River, California

FLOOD CONTROL DIAGRAM

Prepared Pursuant to Flood Control Requirements for Folsom Dam and Lake in accordance with the Code of Federal Regulations, Title 33, Part 208.11

APPROVED *[Signature]*

APPROVED *[Signature]*

Effective Date: November 1966 File No. AM-1-26-

APPENDIX B
PERTINENT CORRESPONDENCE

PERTINENT CORRESPONDENCE

		<u>Page</u>
Department of Water Resources	3 Dec 87	B-1
The Reclamation Board	18 Sep 87	B-3
Sacramento City Council Resolution No. 87-346	5 May 87	B-5
County of Sacramento Department of Public Works	14 Apr 87	B-7

DEPARTMENT OF WATER RESOURCES

1416 NINTH STREET, P.O. BOX 942836

SACRAMENTO, CA 94236-0001

(916) 445-9248

DEC 3 1987

Colonel Wayne G. Scholl
District Engineer
Sacramento District
U. S. Corps of Engineers
Department of the Army
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel Scholl:

By a letter of September 18, 1987 to you, The Reclamation Board indicated its intent to serve as the nonfederal sponsor for a feasibility study of flood control protection for the lower American River and Natomas areas.

The Department of Water Resources recognizes the serious flood threat to developed metropolitan areas and fully supports the proposed study. We urge that the feasibility study be initiated immediately and completed at the earliest possible date. To assist in getting the feasibility study underway, the Department will work with The Reclamation Board on the possibility of providing a modest amount of start-up funds prior to the start of the 1988-89 fiscal year. We are prepared to assist in preparation of the scope of study and cost sharing agreement.

If the Corps and The Reclamation Board desire, the Department is also willing to participate in the feasibility study by providing in-kind services for the evaluation of water supply aspects or other planning tasks. It is anticipated that such services would be credited toward the nonfederal share of study costs.

At the November 13 coordination meeting, each agency was asked to designate representatives to an Executive Committee and a Study Work Group. The Department's representatives will be:

Executive Committee: David N. Kennedy (916) 445-6582
Study Work Group: Linton A. Brown (916) 445-0832 and
Harrold H. Higgins (916) 322-6230

Colonel Wayne G. Scholl
Page 2
DEC 3 1987

We look forward to an early start on resolution of the serious flood problems facing the Sacramento area. If there is anything else we can do to help, please call me at (916) 445-6582.

Sincerely,



David N. Kennedy
Director

cc: Honorable David Houston
Regional Director
Mid-Pacific Regional Office
Bureau of Reclamation
U. S. Department of the Interior
2800 Cottage Way, Room W1105
Sacramento, CA 95825-1898

Mr. Wallace McCormack
President
The Reclamation Board
P. O. Box 157
Rio Vista, CA 94571

THE RECLAMATION BOARD

1416 Ninth Street, Room 455-6

Sacramento, CA 95814

(916) 445-9454

September 18, 1987

Colonel Wayne J. Scholl
District Engineer
Sacramento District
U. S. Corps of Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel Scholl:

By this letter, The Reclamation Board indicates its intent to be the nonfederal sponsor for the investigation entitled "Northern California Streams - American River Watershed".

The Reclamation Board was the nonfederal sponsor for the construction of the Sacramento River and American River Flood Control Project levees which protect the urbanized area in and around Sacramento. These levees were constructed over many years and the Board assumed maintenance and operation responsibilities for the projects upon completion of the work. The February 1986 storm proved that this flood control system is not adequate to provide the flood protection required for a metropolitan area.

You are near completion of the initial analysis of the flooding problem which indicates there are several alternatives which could bring the system up to a reasonable standard of flood protection. The next step is to determine which one is feasible.

This letter of intent is conditioned upon the appropriation of adequate funds by the State Legislature. Funds have been requested which could be available by July 1, 1988. The City and County of Sacramento have also budgeted funds for potential cost-sharing and support The Reclamation Board's action to act as the local sponsor. Under the new cost-sharing formula on feasibility studies, the local sponsor would have an equal voice in the study. It has been suggested that an executive committee be established to manage the investigation.

The Board and the Corps of Engineers have a long history of cooperation on difficult flooding problems. The Board looks forward to working with the Corps in addressing this latest and

Colonel Wayne J. Scholl

Page 2

September 18, 1987

most significant concern. My authorization to submit this letter of intent was given by The Reclamation Board at its September 18, 1987 meeting.

For further information concerning this subject, please call Ray Barsch, General Manager, at (916)445-9454.

Sincerely,

Wallace McCormack

WALLACE MCCORMACK
President

RESOLUTION No. 87-345

Adopted by The Sacramento City Council on date of

MAY 5 1987

A RESOLUTION SUPPORTING COMPLETION OF STUDIES OF THE LOWER AMERICAN RIVER FLOOD CONTROL ALTERNATIVES AND OTHER RELATED STUDIES

WHEREAS, the Corps of Engineers has completed a Special Study on the Lower American River, California, and

WHEREAS, that study establishes that a serious flood threat exists along the Lower American River and that the current level of flood protection is only 63 years, and

WHEREAS, the study indicates that flood protection for the greater Sacramento area is much less than previously believed, and

WHEREAS, the floodplain areas in the greater Sacramento area and along the Lower American River contain an estimated 325,000 people and about \$15 billion in damageable property, and

WHEREAS, the City believes 200-year protection is a minimum desirable for the greater Sacramento area, and

WHEREAS, the existing threat of life and property is significant, and a project needs to be implemented in a minimum period of time, and

WHEREAS, the Special Study indicates upstream storage is the preferable alternative which could provide a minimum of 200-year protection, and

WHEREAS, the Special Study indicates upstream storage at the Auburn site could be implemented in a short period of time

NOW THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF SACRAMENTO THAT:

1. The City supports a flood control project on the American River which will provide a minimum of 200-year protection and can be constructed within the shortest possible time frame.
2. The City supports completion of benefit studies on the Lower American River alternatives.

3. The City supports completion of other flood control studies affecting the City of Sacramento, namely:
 - a. Dry Creek General Investigation
 - b. Sacramento Flood Control System Evaluation
 - c. Sacramento Metro Area General Investigation
4. The City staff upon completion review and various studies and costs to the City of various alternatives and recommend a course of action to the Council.

ANNE RUDIN

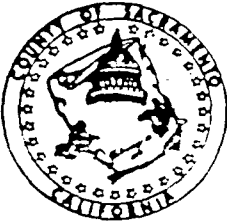
MAYOR

ATTEST:

LORRAINE MAGANA

CITY CLERK

DOUGLAS M. FRALEIGH, Director
TERRY TICE, Deputy Director
W.C. WANDERER, JR., Deputy Director



COUNTY OF SACRAMENTO

DEPARTMENT OF PUBLIC WORKS

COUNTY ADMINISTRATION BUILDING • ROOM 904 • 827 SEVENTH STREET
SACRAMENTO, CALIFORNIA 95814

TELEPHONE: (916) 440-6581

April 14, 1987

APPROVED
BY RESOLUTION # **87-477**
BOARD OF SUPERVISORS

APR 14 1987

Honorable Board of Supervisors
County of Sacramento
State of California

Brenda A. Williams
Clerk of the Board

Subject: RESOLUTION SUPPORTING COMPLETION OF STUDIES FOR THE
LOWER AMERICAN RIVER FLOOD CONTROL ALTERNATIVES AND
OTHER RELATED STUDIES

Members in Session:

RECOMMENDATION:

That your Board approve the attached resolution supporting completion of benefit cost studies on the Lower American River flood control alternatives developed by the Corps of Engineers and other related studies.

DISCUSSION:

The Corps of Engineers recently released its Special Study on the Lower American River, California, which reviews the level of flood protection provided by Folsom Dam and the American River levees. In the study the Corps of Engineers reviewed the American River Basin hydrology, incorporating data gathered since 1961. The data prior to 1961 indicated that Folsom Dam could control all flows up to the 120 year flood. The updated hydrology based on 82 years of record (1905 - 1986) established that the current level of flood protection is only 63 years. The study also indicates that the levees along the Natomas East Main Drain Canal have insufficient freeboard to withstand the 100 year flood.

The study analyzed various alternatives which would increase the level of flood protection for the Lower American River. These alternatives included providing additional flood control storage space in Folsom Reservoir, modifying the spillway in Folsom Dam, strengthening the levees along the Lower American River, increasing allowable downstream flows, providing additional upstream storage, and combinations of these alternatives. The costs of the various alternatives were not determined in the report. The Bureau of Reclamation is developing the cost information for the various alternatives and of benefits and detriments for each alternative or combination. The costs which will enter into those estimates are loss of revenue from decreased water supply and

Honorable Board of Supervisors
April 14, 1987
Page Two

hydropower generation, effects on recreation and fishing both in the reservoir and downstream, and the value of flood damage prevention. It is possible that the Federal Emergency Management Agency's 100 year protection requirements along the American River can be achieved through re-operation of Folsom Reservoir on a short term basis. It should be noted that FEMA's 100 year flood frequency equates to an 85-year flood frequency under the Corps of Engineers' criteria.

Because federal legislation now requires non-federal agencies to pay twenty-five percent (25%) of the costs of flood control projects, it will be necessary for the County to review the cost and benefits of the alternatives before a preferred alternative can be selected. While the 100 year flood protection satisfies the FEMA flood insurance requirements, it may not provide an adequate level of flood protection for the Sacramento metropolitan area. The study points out that the floodplain areas in Natomas, the City of Sacramento, along the Natomas East Main Drain, and along the Lower American River contain an estimated 325,000 people and about \$15 billion in damageable property.

Funding for the local share of the project will be a critical issue for the County, the City of Sacramento and other local flood protection agencies to resolve. Senator Garamendi has introduced a bill to create a Sacramento Regional Flood Control District which could provide the vehicle for the local funding share. Department of Public Works and representatives of the other jurisdictions are working with Senator Garamendi as he develops the legislation.

I recommend that your Board adopt the attached resolution, and I will prepare a recommendation to your Board after the study by the Bureau of Reclamation on the Lower American River Alternatives has been completed.

Respectfully submitted,



Douglas M. Fraleigh, Director
Department of Public Works

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RESOLUTION NO. 87-477

SUPPORTING COMPLETION OF STUDIES OF THE
LOWER AMERICAN RIVER FLOOD CONTROL ALTERNATIVES
AND OTHER RELATED STUDIES

WHEREAS, the Corps of Engineers has completed a Special Study on the Lower American River, California, and

WHEREAS, that study establishes that a serious flood threat exists along the Lower American River and that the current level of flood protection is only 63 years, and

WHEREAS, the study indicates that flood protection for the Natomas area is much less than previously believed, and

WHEREAS, the floodplain areas in Natomas, the City of Sacramento, along the Natomas East Main Drain, and along the Lower American River contain an estimated 325,000 people and about \$15 billion in damageable property, and

WHEREAS, the Federal Emergency Management Agency requires a minimum of 100 year flood protection to meet its flood insurance requirements, and

WHEREAS, FEMA 's 100 year flood protection equates to 85 year flood protection under the Corps of Engineers' criteria, and

WHEREAS, the FEMA flood insurance criteria may not provide the level of flood protection appropriate for the Sacramento Metropolitan area, and

WHEREAS, the study showed various levels of flood protection and suggested measures necessary to achieve each level of flood protection, and

WHEREAS, the study did not develop the costs and benefits of the various alternatives, and

WHEREAS, it is necessary to determine those costs and benefits before a preferred alternative can be selected, and

WHEREAS, the Bureau of Reclamation is currently developing those cost and benefit data, and

WHEREAS, recent federal legislation requires non-federal agencies to share twenty-five percent (25%) of the costs of flood control projects;

NOW, THEREFORE, the Board of Supervisors of Sacramento County resolves as follows:

1. That the 100 year flood protection which satisfies the Federal Emergency Management Agency flood insurance required may not provide an adequate level of flood protection for the Sacramento Metropolitan area.
2. That the Board supports completion of cost benefit studies on the Lower American River alternatives.
3. That the Board supports completion of other flood control studies affecting the Sacramento Metropolitan area; namely, Northern California Streams - Dry Creek (Placer, Sacramento); Northern California Streams, Sacramento Metropolitan Area Interim; Inspection of Completed Works - Sacramento River Flood Control Project (O&M); and American River Watershed (Placer, El Dorado, Sacramento).
4. That County staff review the various studies and costs to the County of various alternatives and recommend a course of action to the Board.

On a motion by Supervisor G. JOHNSON, seconded by Supervisor T. JOHNSON, the foregoing resolution was passed and adopted by the BOARD OF SUPERVISORS of the County of Sacramento, State of California, this 14th day of April, 1987, by the following vote, to-wit:

AYES: Supervisors, I. Collin, G. Johnson, S. Smoley, J. Streng, T. Johnson

NOES: Supervisors, None

ABSENT: Supervisors, None

FILED

APR 14 1987

BOARD OF SUPERVISORS

CLERK OF THE BOARD

ATTEST: Barbara A. Williams
Clerk of the Board of Supervisors

Toby Johnson
Chairman of the Board of Supervisors
of Sacramento County, California

APR 14 1987

Holly A. Donaldson
Deputy Clerk, Board of Supervisors

APPENDIX C
ENVIRONMENTAL ASSESSMENT
AMERICAN RIVER WATERSHED RECONNAISSANCE STUDY

PLANNING DIVISION
U.S. ARMY ENGINEER DISTRICT
SACRAMENTO, CALIFORNIA

JANUARY 1988

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1.0 INTRODUCTION: The Sacramento District has conducted a reconnaissance study of alternative solutions to flooding problems in the Sacramento area. The alternatives include a No-Action alternative, a group of alternatives which would provide flood protection along the American River, a group of alternatives which would provide protection to the Natomas area, and an alternative for both areas in combination. The environmental impacts likely to result from implementation of each alternative are discussed below.

2.0 PURPOSE: The purpose of this environmental assessment is to identify the significant resources in the project area that could be impacted by the individual alternatives and to identify resources that will require additional study if one or more alternatives are selected for further study. To assist in this effort, the U.S. Fish and Wildlife Service Ecological Services Office (USFWS) provided a planning aid letter identifying fisheries, wildlife or vegetative resources that would require additional evaluation during a feasibility phase study (Attachment BB). The resources that have been identified as significant include: vegetation (upland and riparian), fisheries (especially anadromous fish), wildlife, endangered species, recreation, and wild and scenic rivers values (including esthetics). The existing conditions (baseline) for these significant resources will be presented below, as will the baseline for other resources that have been identified as non-significant. The non-significant resources, which will be discussed briefly, include water quality, air quality, geology, soils, and climate. Even though a resource is discussed briefly in this report, there may be reports prepared by other agencies which discuss them in greater detail. Where this occurs, the reader will be referred to that source.

The impact assessments presented in this document are generally qualitative rather than quantitative due to the lack of specific data at this early planning phase. As alternatives are refined during the feasibility phase, studies will be performed to quantify impacts and determine appropriate mitigation measures. This assessment represents a worst-case scenario since specific mitigation measures are not identified. The final selected plan will incorporate the necessary mitigation measures.

3.0 PROJECT ALTERNATIVES: During the plan formulation phase, measures were examined that could singularly, or in combination with other measures provide flood protection to the lower American River and Natomas areas. The measures formulated for the lower American River included new upstream storage, lowering of Folsom Dam spillway, increasing flood control storage in Folsom Reservoir, and increasing the channel capacity below Folsom Reservoir. These measures were then combined in various configurations to develop flood control alternatives that could provide protection against 100-year, 150-year, and 200-year and greater flood events. It was determined that flood protection for the lower American River would help, but not resolve flood

problems in the Natomas area. As a result, a separate group of alternatives was developed to address flooding in the Natomas area. The alternatives developed are actually a representative sample of a broader range of possible alternatives. The components of each alternative could range in magnitude, depending on local support and environmental impacts.

Several of the measures that were initially evaluated and found to be infeasible. These included raising Folsom Dam, construction of off-stream storage, construction of out-of-basin conveyance systems, construction of reservoirs upstream of Natomas on Coon Creek and/or Auburn Ravine, and use of existing water supply and hydropower reservoirs in the upper American River watershed for flood control storage. A more complete discussion of these measures and why they were eliminated from further study can be found in the accompanying Reconnaissance Report.

The project alternatives discussed below will all be compared to the baseline condition and the No Action Alternative to determine the probable future impacts resulting from each individual alternative. Detailed descriptions of each alternative can be found in Chapter IV, Plan Formulation.

3.1 American River Alternatives

A. No Action Alternative. This alternative was studied to define the effect of no Federal action in response to flood control problems within the area of investigation. The no action alternative was given consideration equal to all other alternatives.

B. 100-Year Level of Protection

1. Increase Lower American River Channel Capacity and Objective Release From Folsom Reservoir. This alternative consists of increasing the objective release from Folsom Reservoir from 115,000 cubic feet per second (cfs) to 180,000 cfs. To accommodate this discharge, significant modifications to the levee and stream bank along the lower American River would be necessary.

2. Increase Flood Control Storage and Objective Release at Folsom Reservoir and Increase Channel Capacity Along Lower American River. This alternative consists of increasing the maximum designated flood control storage space in Folsom Reservoir from 400,000 to 630,000 acre-feet (ac-ft) and increasing the objective release from Folsom Dam from 115,000 cfs to 130,000 cfs. Downstream levee, river bank, and structural modifications would be necessary.

3. Increase Flood Control Storage and Lower Spillway at Folsom Dam. This alternative involves increasing the maximum flood control storage space to 650,000 ac-ft and lowering five service gates at Folsom Dam spillway by 15 feet.

C. 150-Year Level of Protection.

1. Increase Flood Control Storage and Objective Release, Lower Spillway, and Increase Channel Capacity in Lower American River. This alternative consists of increasing the maximum seasonal flood control space in Folsom Reservoir to 620,000 ac-ft, increasing the objective release to about 180,000 cfs, and lowering five service gates at Folsom Dam spillway by 15 feet. Levee, river bank, and structural modifications would be required.

2. Construct New Upstream Flood Detention Dam. This alternative consists of constructing a 420,000 ac-ft reservoir at the Auburn site. Approximately 390,000 ac-ft of storage would be for active flood control and 30,000 ac-ft would be reserved for sediment storage. This reservoir would normally be empty and would store water only for short periods during high flow conditions.

D. 200-Year Level of Protection.

1. Construct New Upstream Flood Detention Dam. This alternative consists of constructing a 570,000 ac-ft dam and reservoir at the Auburn site. An estimated 540,000 ac-ft of the new storage would be for active flood control and 30,000 ac-ft would be for sediment storage. This reservoir would normally be empty and only store water for short periods during high flow conditions.

2. Construct New Upstream Small Multipurpose Reservoir. This alternative consists of constructing an 850,000 ac-ft reservoir at the Auburn site. The facility would include 600,000 ac-ft for flood control storage. The flood control space in Folsom Reservoir would be reduced to 300,000 ac-ft. The remaining capacity would be used for either water supply or hydropower generation.

3. Construct New Upstream Large Multipurpose Reservoir. This alternative would be similar to the project mentioned above but with a total storage capacity of 2.3 million ac-ft.

3.2 Natomas Area Alternatives

A. 100-Year Levels of Protection

1. Construct Levees with Gated Structure and Pumping Station at Natomas Cross Canal. This alternative consists of levee improvements around the entire Natomas area and construction of a gated structure and pumping station at the Natomas Cross Canal.

2. Construct Cross Levee at Del Paso Road. This alternative would include improvements of levees located south of Del Paso Road and construction of a cross levee near Del Paso Road. This alternative would protect approximately one-fourth of the Natomas area, which is the most heavily populated.

3. Construct Cross Levee at Elverta Road. This alternative is similar to the Del Paso Cross Levee plan, however, the cross levee would be constructed further north near Elverta Road, affording flood protection to approximately the southern half of the Natomas area, including the Sacramento Metropolitan Airport.

B. 200-Year Level of Protection.

The components of the three alternatives listed above would be retained, however, levee work would be more extensive, pumps would have larger capacities, bridges would be raised higher, and the apron at the Sacramento Weir would be enlarged.

4.0 ENVIRONMENTAL SETTING

4.1 American River

A. General. The upper American River watershed, within the study area, encompasses the North and Middle Forks of the American River and lies along the western slope of the Sierra Nevada mountain range. The roughly triangular drainage basin begins near Highway 88 at Carson Pass and runs nearly 45 miles to Interstate 80 at Soda Springs and narrows to a point at Folsom Lake. Approximately 343 square miles of the watershed drains into the North Fork, while the Middle Fork receives runoff from 619 square miles. The area is typical of the western Sierra and is characterized by rugged, steep canyons (Haines and Cooley 1984).

The portion of the lower American River located in Sacramento County, meanders through a 4,800-acre flood plain that is bordered for the most part by low bluffs in the upper course and levees along the lower course. The lower American River extends 23 miles from Nimbus Dam downstream to its confluence with the Sacramento River. In 1955, the lower river was controlled by the construction of Folsom Dam and Reservoir and its lower regulating Nimbus Dam and Lake Natoma. The mean annual runoff at Folsom Dam is about 2.8 million acre-feet. Most of the flood plain between the levees has been acquired by either the City or the County of Sacramento, and is managed cooperatively as the American River Parkway.

The American River Parkway is a recreation and open space greenbelt that meanders through the Sacramento urban area. It contains about 4,800 acres of land within the floodway boundaries. There are several intensely developed recreational areas, but most of the area is in a naturalistic condition (Nance and Ueda 1977).

B. Geology. The Upper American River watershed, specifically the Auburn Dam site, is generally considered to be a single block of the earth's crust. Underlain by Paleozoic and Mesozoic age sedimentary and volcanic rock, this area has been intensely deformed by folding and faulting. Subsequent uplift and erosion has removed most of this material, exposing the granitic base material that is the primary component of the Sierra Nevada Range. An area of alluvial uplands near the City of Folsom separates the upper basin from the flood plains below (Shulters 1982; USBR 1972).

The lower American River is located on the eastern side of the Sacramento Valley, which comprises the northern portion of the Central Valley of California. The valley is a major structural trough 500 miles long and 40 to 50 miles wide. The oldest formations are within the valley; its crystalline foundation and overlying marine Cretaceous shales and sandstones are covered at

and downstream of Nimbus Dam by a thick blanket of essentially continental Cenozoic deposits. The closest exposures of Sierran granitic rocks and marine near-shore fossiliferous Upper Cretaceous sandstone are near the City of Folsom (USBR 1974).

C. Soils. The upper American River can be grouped into three physiographic units: the lower foothills, the upper foothills and the mountainous uplands. Generally, the soils of the lower foothills have developed from materials accumulated by residual decomposition of various rocks, primarily igneous that have undergone considerable erosion. The upper foothill and mountainous upland consists of deeply dissected canyons and steep-sided, flat-topped ridges. On the ridge parallel to and northwest of the North Fork of the American River, the soils have developed from residual material derived from metamorphosed sedimentary rocks and form an irregular surface. The soils on the comparatively flat ridge tops are deeply weathered and were derived from andesitic sediments, which overlie the metamorphic rocks of that region. There are also a few ancient alluvial deposits in the area, but they have been placer mined and replaced by placer diggings and tailings with only a few remnant deposits remaining (USBR 1972).

The lower American River channel and flood plains are cut into Laguna and Victor formations (e.g., granitic sands, silts, clays and gravelly channels). Hardpan layers in these formations are probably responsible for some riffles and bars present in the channel. The youngest natural deposits are represented by streambed gravel and sand associated with fine-grained flood plain alluvium deposited during winter floods over the Victor formation, and some local fine grained basin deposits in sinks and marshes. It appears that much of the channel gravel originated from extensive gold dredging (USBR 1974).

Within the flood plain of the lower American River are over 7,700 acres of prime and unique farmlands. Most of this land occurs north of the American River in the Natomas area (City of Sacramento 1987). The U.S. Soil Conservation Service (1979) has identified several soil types within the vicinities of Auburn Ravine and Coon Creek that would qualify as prime and unique farmlands. Areas in the upper American River watershed are generally too steep (slopes greater than 9%) to qualify as prime and unique farmlands.

D. Climate. The majority of precipitation in the American River Basin is provided by air masses moving in from the Pacific Ocean during the winter months. These storms usually move through the area from the west or northwest. In the upper American river basin, the average annual precipitation varies greatly from year to year with a 30-year high at Auburn of 59.13 inches and an average annual precipitation of 35.10 inches. Average monthly precipitation reaches its maximum in January with slightly more than 7 inches at Auburn. July and August are dry months with just a trace of precipitation.

Snowfall over the area varies from an average of less than 5 inches total for the year (one inch at Auburn) to over 200 inches at the 5,500 foot level.

Temperatures generally decrease as elevation increases. Variations also occur due to differences in aspect and exposure to the wind and sun. Summer high temperatures in Auburn average in the middle 90's, with nighttime temperatures in the low 60's. Winter highs average in the middle 50's with minimums in the middle 30's. The mean number of days between periods of freezing temperatures is 275 at Auburn (USBR 1974).

The lower American River has a long, warm, dry summer season from May through October. It is followed by a cool rainy season during November and continuing through April. Most of the rain falls during the 4 months of December through March. Normal annual rainfall for Sacramento is about 16 inches. During the summer, daytime temperatures often exceed 100 degrees F. The winter temperatures are mild and rarely drop below 20 degrees F. Clear skies predominate throughout most of the year, but storms and fog frequently occur during the winter months (USBR 1974).

E. Air Quality. Overall air quality in the Upper American River Basin is excellent. Vehicles from Interstate 80, U.S. 50, Highway 49, and other roads in the area, and some commercial and industrial sites are the source of emissions for the area. Both Placer and El Dorado Counties have active air pollution control programs.

Pollutant sources in the Sacramento Valley, including the American River Basin, are classified as urban. The Federal air quality standards for ozone and carbon monoxide are currently being exceeded several times per year. Major contributors to the regional ozone problem as identified by the Sacramento Air Quality Plan are: motor vehicle emissions, evaporation of various organic compounds from pesticide use, industrial processes, and non-highway mobile sources (boating, off-road vehicle use and aircraft operation) (City of Sacramento 1987).

F. Water Quality. Even though the natural condition of the American River has been altered by man's activities, the overall water quality is good and suitable for all beneficial uses. In the past 20 years, levels of dissolved solids, hardness, and alkalinity have increased downstream from treated effluent and urban runoff sources. Dissolved oxygen and pH have remained steady. Most violations of specific water quality objectives for the basin have occurred in the lower American River. This is expected to improve as sewage treatment discharges into the river are phased out (Shulters 1982).

Recreational overuse, improper land use, or poorly managed mining operations are potential sources of future water quality problems in the upper American River Basin. Recreational overuse and increased urban runoff are potential threats to water quality in the lower American River (Shulters 1982).

4.2 Natomas Area

A. General. The Natomas area encompasses approximately 53,000 acres and is divided into two areas by Interstate 80. The South Natomas area is completely within the City of Sacramento. The North Natomas area includes lands within the City of Sacramento, Sacramento County, and Sutter County. The lands within the city total approximately 14,280 acres (4,880 ac in South Natomas and 9,400 acres in North Natomas).

The area within Sacramento and Sutter Counties encompasses approximately 37,700 acres. The Sacramento Metropolitan Airport, and approximately 2,000 acres of airport related industrial land, are included in this area. Land uses are mainly agricultural, with public and private uses, including industrial development and vacant lands. The developed areas include Metro Airport, Natomas Air Park, the Natomas Sewer Treatment Pumping Station, and low density residential areas.

B. Geology. The Natomas area, like most portions of the Central Valley, is situated on vast alluvial deposits that have slowly accumulated over the last 100 million years. The materials have been derived from the surrounding uplands, transported by major streams, and deposited in successive clay, silt, and sand and gravel layers on the river flood plains, in local sinks, or within the shallow seas that periodically covered the valley floor.

The surface sediments within Sacramento are primarily of three kinds: the older Victor formation, recent flood plain deposits and recent basin deposits. These deposits represent the depositional regime of the area immediately prior to stream flow and drainage changes brought about within the last 135 years (City of Sacramento 1987).

C. Soils. The surface soils in the Natomas area have developed on alluvial soils, which under natural conditions, would be periodically flooded. The construction of dams and levees have reduced the flooding. The soils that are most common in the Natomas area are: The Columbia-Cosumnes Series, The Clear Lake Series and The San Joaquin Series. The Columbia-Cosumnes soils are very deep, poorly drained soils that have developed on flood plains. The surface drainage is good, but the subsoil drainage is greatly restricted by the hardpan layer (City of Sacramento 1987).

D. Climate. The climate for the Natomas area is very similar to conditions in the lower American River Basin previously discussed.

E. Air Quality. Overall air quality for the Natomas area would be similar to air quality in the lower American river Basin previously discussed.

F. Water Quality. Both the American and Sacramento Rivers at Sacramento are of good quality, although the quality of the American River is usually better. Upstream water development affects the quality of water in both the Sacramento and American Rivers. Extensive irrigated agriculture upstream of Sacramento tends to degrade the quality of Sacramento River water. During the spring and fall, irrigation tailwaters are discharged into drainage canals that flow to the river. In the winter, runoff flows over these same areas. Both flows are not only highly turbid, but also introduce large amounts of herbicides and pesticides, especially rice field herbicides, into the drainage canals.

Water quality degradation of the American River is relatively minor due to the limited irrigation and return flows in the surrounding area. The Sacramento Regional Wastewater Treatment Plant has reduced waste disposal to the American River (City of Sacramento 1987).

5.0 VEGETATION

5.1 Affected Environment - American River.

The 23-mile reach of the lower American River contains a 4,800-acre flood plain, of which approximately 1,700 acres are composed of grassland habitat and 960 acres are in riparian and oak woodlands, with the remainder in gravel bars and open water (USFWS 1986).

The native vegetation of the flood plain of the lower American River has been greatly modified by land disturbances and by introduced plants. Five vegetative communities have been described in the lower American River area. These are foothill woodland, valley grassland, chaparral, riparian, and freshwater marsh (USBR 1974).

Three physical zones, representing a gradient from high to low tolerance of inundation, have been described for the riparian community in the lower American River (Sanders, et al. 1985). The lowest zone is the scrub willow community, which colonizes gravel bar areas. Woody vegetation associated with the higher areas of this zone are young cottonwoods, box elders, white alders, and Oregon ash. Typical herbaceous vegetation includes goldenrod, sorrel, muhleygrass, and vervain. The next zone is the border zone, which is comprised of cottonwoods, white alder, Oregon ash, Gooding's willow, California sycamore, elderberry, live oak, valley oak, California black walnut, wild rose, and wild grape. The highest zone is characterized by digger pine, California buckeye, western redbud, snowberry, and deer brush (Sanders, et al. 1985).

The proposed Auburn Reservoir site is characterized by a steep river canyon composed of five plant communities including chaparral, foothill woodland, valley grassland, riparian woodland, and montane coniferous forest (USFWS 1987). The Auburn Reservoir area represents a transitional zone between the woodland of the lower foothills and the coniferous forest of the mountains (USBR 1972).

The valley grasslands are principally composed of exotic grasses, such as brome grass, bluegrass, and barley. The chaparral communities is characterized by chamise, manzanita, buckbrush, toyon, and yerba santa. The foothill woodland community is composed of both deciduous and evergreen species and includes interior live oak, blue oak, and digger pine. Riparian woodlands are confined to narrow corridors adjacent to river banks, edges of ponds, and marshes. Typical species include cottonwood, box elder, willow, and Oregon ash. The montane coniferous forests occur at higher elevations and include ponderosa pine, Douglas-fir, bigleaf maple, and black oak (USFWS 1987).

5.2 Environmental Impacts - American River.

A. No Action. Under the no action alternative, vegetation in the upper basin would not be significantly impacted due to the remote nature of the area. Streamside vegetation is likely to recede as water diversions, permitted by the State Water Quality Control Board, increase and instream flows are reduced.

B. 100-Year Level of Protection

1. Increase Lower American River Channel Capacity and Objective Release From Folsom Reservoir. Under this alternative, the objective release from Folsom Reservoir would be increased from 115,000 cfs to 180,000 cfs. It is estimated that 18 miles of levees would be raised to provide the freeboard necessary to contain flood flows.

In order to prevent the setback levees from eroding during high discharges, it would be necessary to riprap approximately 21 miles of bank and levee along the lower American River. Impacts to vegetation would be minimal on the levee systems since only herbaceous vegetation is permitted. However, over 150 acres of mature riparian vegetation would be removed in order to install the riprap revetment.

Detailed studies of the proposed riprap sites, as well as intensive habitat investigations, will be necessary to determine the magnitude of the potential impact to the vegetative communities and the required mitigation measures.

2. Increase Flood Control Storage and Objective Release at Folsom Reservoir and Increase Lower American River Channel Capacity. Under this alternative, the objective release from Folsom Reservoir would be increased from 115,000 cfs to 130,000 cfs. Approximately 2 miles of levees would need to be raised to increase the levee freeboard. Approximately 14 miles of bank and levee stabilization would require the removal of approximately 100 acres of mature riparian vegetation.

Increasing the flood control storage space in Folsom Reservoir would increase the annual fluctuation of the lake level, particularly between late summer and early fall, in preparation for winter rains. Shoreline vegetation would be adversely effected as the frequency and duration of inundation is altered.

3. Increase Flood Storage and Lower Spillway at Folsom Dam. As discussed above, increasing the flood control storage space in Folsom Reservoir would increase the annual fluctuation of the lake level, particularly in late summer and early fall in preparation for winter rains.

Lowering of the spillway on Folsom Dam is not expected to have any appreciable impact on vegetation at Folsom Reservoir or along the lower American River.

C. 150-Year Level of Protection

1. Increase Flood Control Storage and Objective Release and Lower Spillway at Folsom Reservoir and Increase Lower American River Channel Capacity. See 5.2B(1-3) above for a description of impacts associated with increasing channel capacity and increasing flood control storage space.

2. Construct New Upstream Flood Detention Dam. The impacts to vegetation resulting from construction of a 420,000 ac-ft dry dam would be similar to those described in 5.2D(1) below.

D. 200-Year (or Greater) Level of Protection

1. Construct New Upstream Flood Detention Dam. The impacts to vegetation resulting from construction of a 540,000 ac-ft dry dam would include temporary removal of vegetation during construction. Long-term impacts to vegetation would be less than those associated with any permanent water storage plan. Impacts to vegetation during flood events would depend on the frequency, duration, and timing of inundation, operational release procedures, and the species association. Box elder, white alder, cottonwood, and willow are classified as very tolerant to flooding for periods in excess of two growing seasons. Oregon ash can tolerate flooding up to one growing season. Valley oak, bigleaf maple, ponderosa pine, Douglas-fir, California laurel, and redbud can survive flooding for one to three months during the growing season. Based on these findings, USFWS (1987) suggested that the dominant plants of the riparian forest, valley woodland, and montane coniferous forest communities in the Auburn area could tolerate inundation for as long as one month during both the growing and dormant seasons.

Based on information developed to date, it is expected that the reservoir would be partially filled once every ten years, and that would occur during the winter rainy season. Duration of inundation is expected to be less than two weeks for the design event. Based on this preliminary scenario, it is expected that impacts to vegetation would not be significant because duration and frequency of inundation would be limited and would occur during the dormant season when vegetation, particularly trees, are more tolerant of inundation. More detailed analysis will be performed during feasibility phase if this alternative is selected for further review.

2. Construct New Upstream Small Multipurpose Reservoir. Construction of a 850,000 ac-ft multipurpose reservoir would inundated approximately 5,300 acres and 37 miles of stream, resulting in significant losses of vegetation.

3. Construct New Upstream Large Multipurpose Reservoir. Construction of a 2.3 million ac-ft multipurpose reservoir would result in the inundation of 10,000 acres and 48 miles of stream channel. Significant losses would result and have been described previously (USBR 1972, 1974, 1975, 1980; USFWS 1986).

5.3 Affected Environment - Natomas Area.

The Natomas area within the American River basin is dominated by agricultural lands, however, several well developed stands of cottonwood riparian forest vegetation, bordering the drainage canals, occur in the Natomas area. The riparian sites are also associated with narrow strips of emergent wetland vegetation. These sites include Fisherman's Lake, portions of the west drainage canal, scattered sites along Del Paso Road near I-80, and northeast of the Sacramento Metropolitan Airport (City of Sacramento 1987). Typical woody vegetation includes sandbar willow, Fremont cottonwood, black willow, button willow, alders, western sycamore, wild grape, and elderberry. The non-woody riparian/wetland vegetation includes emergent plants such as cattails, sedges, and bulrushes. A large part of the Natomas area is in rice production, which is an important habitat to wildlife, serving as an alternative to natural marshlands (City of Sacramento 1985).

5.4 Environmental Impacts - Natomas Area.

A. No Action Alternative. Under the no action alternative, it is expected that streamside vegetation, as well as agricultural lands, will be impacted as development within the Natomas area increases. In the reconnaissance report it is assumed for economic purposes that development will not increase after 1990 due to flood plain restrictions. However, in reality, growth would proceed, but at a slower rate than under a flood-free scenario due to high costs required to provide adequate flood protection to new areas.

B. 100/200-Year Level of Protection

1. Construct Levees with Gated Structure and Pumping Station at Natomas Cross Canal. Approximately 30-40 percent of the levee system encircling the Natomas area would need to be raised under this plan. Significant stands of vegetation along the Natomas East Main Drainage Canal and the Sacramento River could be impacted during construction. The magnitude of the impact will largely depend on the areas to be raised and whether the landward side or the canal side of the levees are used to stage construction. Losses of riparian vegetation is particularly significant in the Natomas area due to its scarcity.

2. Construct Cross Levee at Del Paso Road.

Construction of a cross levee along the Del Paso Road alignment would have little impact on non-agricultural vegetation along the proposed levee alignment. Impacts to vegetation along existing levees would be similar to those described above although the area of impact would be greatly reduced.

3. Construct Cross Levee at Elverta Road.

Construction of a cross levee along the Elverta Road alignment would have little impact on non-agricultural vegetation along the proposed levee alignment. Impacts to vegetation along existing levees would be similar to those described above although the area of impact would be reduced.

6.0 FISHERIES

6.1 Affected Environment - American River.

The fisheries of the lower American River have been studied extensively as a result of planning and operation of Folsom Reservoir; planning for the proposed Auburn Dam (Gerstung 1971; USFWS 1983, 1984a, 1984b, 1985; Snider and Gerstung 1986); litigation between the Environmental Defense Fund, et al. and the East Bay Municipal Utilities District over contracted diversions of water through the Folsom-Natomas South Canal (Hecht 1984; Kelley, et al. 1985a, 1985b; Rich and Leidy 1985; Meyer Resources, Inc. 1985); and planning for flood control (USFWS 1986, 1987). More detailed information on the American River fishery can be found in these reports.

The lower American River system provides a wide array of aquatic habitat types. As a result of this habitat diversity, at least 41 species of fish are known to inhabit the system (Gerstung 1971). Species most important from a commercial and recreational standpoint include chinook salmon, American shad, steelhead trout, and striped bass.

Natural reproduction and hatchery propagation account for 60 percent and 40 percent, respectively of the chinook salmon production in the lower American River (USFWS 1987). This production results in an annual contribution of over 190,000 harvestable-sized salmon (over 1 million pounds) to the fishery (USFWS 1983; Snider and Gerstung 1986). Approximately 47 percent of the American River chinook are caught in the ocean commercial fishery, 25 percent in the ocean sport fishery, and 3 percent in the river sport fishery. The remaining 25 percent escape to spawn naturally in the river or in the hatchery (USFWS 1983).

The steelhead run on the lower American River averages 20,000 fish, of which 95 percent are hatchery produced. Natural production is low because during their year instream rearing, the young are subjected to lethal temperatures in summer, high predation, and angler harvest (USFWS 1987).

The American shad population in the lower American River is approximately 500,000 fish, and have become a popular sport fish. The river serves as a spawning ground for shad, however, once spawned, the eggs drift downstream and the young are reared in the Delta. Striped bass are present in the river during most of the year, but no significant spawning is thought to occur (USFWS 1987).

Other common game fishes include rainbow trout, smallmouth bass, largemouth bass, white crappie, bluegill, and catfish. Common non-game species include carp, Sacramento squawfish, Sacramento sucker, hardhead, and tule perch (USFWS 1987).

Total revenues associated with the commercial catch of lower American River chinook salmon have been estimated at \$9,252,000 (1984 dollars) annually (Meyer Resources, Inc. 1985). Total market and non-market values associated with the total American River recreational fishery (salmon, steelhead, shad, and striped bass) has been estimated to range from \$3,868,000 to \$12,478,000 annually (Meyer Resources, Inc. 1985).

The sport fishery at Folsom Reservoir consists of largemouth bass, smallmouth bass, rainbow and brown trout, kokanee salmon, and sunfish. The reservoir has experienced low natural production as a result of fluctuating water levels. This, in turn, has resulted in low angler use. USFWS (1984) estimated angler use at 120,000 days annually versus 150,000 days at Lake Natoma.

The principal game fishes occurring along the North and Middle Forks of the American River in the general vicinity of the proposed Auburn Dam are rainbow trout, brown trout, and smallmouth bass. A small run of Kokanee salmon migrate into the area from Folsom Lake. Native fish species in the area include rainbow trout, Sacramento squawfish, hardhead, and Sacramento sucker (USBR 1972). An estimated 5,000 angler-days are spent on Lake Clementine on the North Fork American River, and about 8,000 angler-days are spent on the river reaches between Folsom Reservoir and Lake Clementine (USFWS 1987).

6.2 Environmental Effects - American River

A significant environmental impact to the lower American River fishery, particularly related to upstream storage plans, involves the level of flow releases into the river from Folsom Reservoir. At present, flows in the lower American River are regulated by Decision 893 (D-893) of the California State Water Resources Control Board (SWRCB). This regulation was promulgated in the early 1950's in expectation of water storage in the proposed Folsom Reservoir. Under this decision, USBR is required to provide discharges of 500 cfs during the salmon spawning season (15 Sep - 01 Jan), and releases of 250 cfs during the remainder of the year.

In anticipation of increased storage capabilities provided by the proposed Auburn Reservoir, SWRCB revised flow requirements in the lower American River when the Auburn Reservoir is operational. This revised instream flow requirement, Decision 1400, requires fishery releases of 1,250 cfs between 15 Oct and 15 Jul, and 300 cfs for the remainder of the year. Flows of 1,500 cfs would be required for recreational purposes between 16 Jul and 14 Oct. However, on the basis of recent instream flow studies (USFWS 1985; California Department of Fish and Game - CDFG 1985), it has been determined that even the higher flow levels mandated by D-1400 would be inadequate to maintain the necessary stream habitat required to sustain post-Folsom salmon populations in the lower American River.

CDFG (1985) has estimated that in order to optimize conditions for fish resources in the lower American River, releases of 1,750 to 4,000 cfs would be necessary during the spawning season; 3,000 to 6,000 cfs during rearing (01 Mar - 01 Jul); and, 1,500 cfs for the remainder of the year. USFWS (1985) calculated that to maintain existing runs of salmon, releases of 1,750 to 2,000 cfs would be necessary during spawning (15 Oct - 31 Dec); 1,250 cfs during rearing (01 Jan - 31 Mar); and either 1,250 cfs or flows sufficient to maintain the instantaneous temperature at the mouth of the lower American River at 65 degrees F. Analyses performed by Rich and Leidy (1985) and Kelley et al. (1985) also concluded that D-1400 flow levels would be too low to sustain the existing salmon spawning levels. Kelley et al. (1985) determined that rearing flows required by D-1400, and rearing flows recommended by CDFG and USFWS were too great and suggested that flows between 500 and 750 cfs would maximize juvenile rearing habitat.

From these data, it is apparent that if contracted water supplies were diverted from the lower American River, and the minimum SWRCB instream flow requirements were realized, significant habitat losses and corresponding reductions in the fisheries would result. It is likely, however, that these population reductions would be commercially and environmentally unacceptable and SWRCB may be required to revise minimum flow requirements.

A. No Action. Under the no action alternative it is expected that the fishery in the lower American River will decline as instream flows are reduced as a result of increasing diversions. It is likely, as described above, that at some level of decline, political pressure may require SWRCB to intervene and revise flow requirements.

B. 100-Year Level of Protection

1. Increase Lower American River Channel Capacity and Objective Release From Folsom Reservoir. Fishery impacts associated with bank stabilization and upgrading of the levee system to convey sustained objective releases of 180,000 cfs would include a significant loss of habitat resulting from the removal of extensive stands of riparian timber, grading of undercut banks, and the destruction of rearing and spawning areas with rock riprap. The increased flows would hasten the loss of spawning gravels and the removal of the riparian canopy could increase water temperatures at the bankline.

Additional studies would be required to quantify the extent of potential fishery losses attributable to project alternatives.

2. Increase Flood Control Storage and Objective Release at Folsom Reservoir and Increase Lower American River Channel Capacity. See 6.2B(1) above. Impacts to the fishery at Folsom Reservoir would be dependent upon the timing of the drawdown of the multipurpose pool to accommodate the additional flood storage increment. In general, those species utilizing shoreline spawning areas during late-summer through early-winter would experience a reduction of habitat due to the reduced submerged surface area. Increased discharges into the lower American River during this period would likely enhance chinook salmon and steelhead spawning by providing increased attraction flows and additional spawning habitat. A net loss of rearing habitat, as well as possible temperature problems, could result in late spring through summer as outflows from the reservoir are reduced to raise the water surface to multipurpose pool.

3. Increase Flood Control Storage and Lower Spillway at Folsom Dam. See 6.2B(2) above. Lowering the spillway would allow objective releases into the lower American River earlier in the flood event. No significant change over the existing conditions would result.

C. 150-Year Level of Protection

1. Increase Flood Control Storage and Objective Release and Lower Spillway at Folsom Reservoir and Increase Lower American River Channel Capacity. See 6.2B(1-3) above.

2. Construct New Upstream Flood Detention Dam. Construction of a 420,000 ac-ft flood water detention dam would have impacts similar to those described below in 6.3D(1).

D. 200-Year (or Greater) Level of Protection

1. Construct New Upstream Flood Detention Dam. Construction of a 570,000 ac-ft flood detention dam and reservoir could potentially inundate 37 miles of stream habitat during the design flood event. However, in most years flows would not be impeded and impacts to the existing fishery would be minimal. It is expected that some water would be backed-up in the reservoir once every ten years and would drain within one to two weeks. A single-purpose dry dam would not provide the potential benefit of cold water storage, nor would it dampen the water level fluctuations at Folsom Reservoir that would be possible with a larger multi-purpose reservoir. Because water storage would not be a project purpose, the dry dam would neither be capable of, nor required to ensure D-1400 flows to the lower American River.

2. Construct New Upstream Small Multipurpose Reservoir. See 6.2D(3) below.

3. Construct New Upstream Large Multipurpose Reservoir. Fishery impacts expected to result from the construction of a large, multi-purpose Auburn Dam have been described in detail in previous reports (USBR 1972, 1974, 1975, 1980; USFWS 1986). Principal impacts include the loss of 47 miles of river channel along the North and Middle Forks of the American River, including segments of Lake Clementine, and replacement of a riverine fishery with a reservoir fishery. USFWS (1980) has estimated that approximately 20,000 angler-days of high quality brown and rainbow trout would be lost annually. Approximately 19,000 angler-days of quality reservoir fishing in Lake Clementine would be replaced with lower quality reservoir fishing in Auburn Lake. The reduced quality is anticipated as a result of severe water level fluctuations and limited food producing littoral zone of the steep-banked Auburn Lake. Auburn Dam would have a positive effect on the Folsom Lake fishery by reducing the level of fluctuation it has experienced in the past.

If a large, multi-purpose Auburn Dam were constructed, the discharges into the lower American River would be modified. Under D-1400, stream flows below Nimbus Dam would be maintained at 1,250 cfs from 15 October to 15 July, and 800 cfs the remainder of the year to maintain the fishery resources in the lower American River. Although this is an improvement in the current instream flow requirements mandated by D-893, it nevertheless represents average flows far less than have occurred in the past 30 years.

6.3 Affected Environment - Natomas Area.

The canal system surrounding the Natomas area does not contain a significant fishery resource, due largely to the ephemeral nature of flows and high water temperatures. The resident fish population in the canal system probably include catfish, carp, and suckers. Angler use is relatively low and concentrated at bridges (USFWS 1987). During the rainy season, the Natomas Cross Canal and Natomas East Main Drainage Canal provide access to migrating salmon to spawning sites in the Auburn Ravine, Dry Creek, and Coon Creek watersheds.

6.4 Environmental Impacts - Natomas Area.

A. No-Action Alternative. It is likely that portions of the Natomas area will continue to develop in the future with or without Federal assistance in providing flood control. In order to achieve adequate levels of protection, additional levee work would be required. Enlargement and improvement of the existing levee system would not impact the fishery since construction would probably be performed during the dry season when the canals have minimal flows. No long-term impact to the fishery is expected.

B. 100/200-Year Level of Protection

1. Construct Levees with Gated Structure and Pumping Station at Natomas Cross Canal. No long-term impacts to fishery resources are expected under this alternative. Short-term adverse impacts on migration to spawning areas in Auburn Ravine and Coon Creek could occur during flood events when flood-gates are closed. Pumping operations could be expected to cause some mortalities to fishes entrained on intake screens.

2. Construct Cross Levee at Del Paso Road. Construction of a cross levee across existing agricultural lands would not impact the fishery.

3. Construct Cross Levee at Elverta Road. Construction of a cross levee across existing agricultural lands would not impact the fishery.

7.0 WILDLIFE

7.1 Affected Area - American River

The lower American River contains 4,800 acres of flood plain and 4,000 acres of adjacent undeveloped uplands. Vegetation types in this area include riverine, freshwater marsh, riparian, foothill woodland, valley grassland, chaparral, dredger tailings and agriculture. This is one of the largest riparian areas in the country surrounded by urban development. (USFWS 1987). Within the lower American River Parkway, approximately 2,670 acres of land have been designated as Open Space Reserve, Nature Study Area, or Protected Area (Nance and Ueda 1977). These areas provide the highest quality of habitat for wildlife, and land use restrictions imposed by Sacramento County have limited disturbances to wildlife populations.

USFWS (1987) reported that more than 220 species of birds, 50 species of mammals, and substantial numbers of reptiles and amphibians inhabit the lower American River ecosystem. The interspersed of dense, mature riparian and oak forests with open grasslands and continuous water sources, yield high quality habitat.

Characteristic bird species of the riparian and oak forests include red-tailed and red-shouldered hawks, black-shouldered kite, California quail, Nuttall's and downy woodpeckers, scrub jay, American crow, plain titmouse, house wren, rufous-sided towhee, song sparrow, and house finch. Typical mammals of this habitat include black-tailed deer, gray fox, raccoon, opossum, gray squirrel, and ringtail (USFWS 1987).

Grassland habitat species include American goldfinch, western meadowlark, California ground squirrel, and gopher snake. The river, dredger ponds, and backwater areas are used by great blue heron, wood duck, mallard, belted kingfisher, beaver, muskrat, river otter, bullfrog, and western pond turtle (USFWS 1987).

Lands surrounding the proposed Auburn Dam and Reservoir provide habitat for a wide variety of wildlife. Typical mammal species of the foothill woodland, montane coniferous forest, valley grassland, and riparian forest communities include black-tailed deer, gray fox, western gray squirrel, coyote, raccoon, striped skunk, and spotted skunk (USFWS 1987). Wildlife is particularly abundant in this area because hunting has been prohibited since government acquisition of the land for the project. This is a critical area for black-tailed deer, which migrate from the higher elevations into the foothills during the winter months. Black bear have been found in the steep canyons of the North and Middle Forks of the American River. The bobcat population is small and prefers brushy hillsides with heavy cover and rocky outcroppings. Large numbers of ringtail cats and

raccoons are found in the canyons near the water. Striped skunks, spotted skunks, weasels, gray squirrels, brush rabbits, and opossum occur in the area up to 6,000-foot elevation.

Mountain and valley quail, red-tailed and Cooper's hawk, wild turkey, acorn woodpecker, scrub jay, wrentit, bushtit, Hutton's vireo, and California thrasher are representative bird species in the Auburn area. Common waterfowl in the area include the mallard, American merganser, and wood duck. Migratory game birds common in the basin include the mourning dove and the pacific band-tailed pigeon.

Thirty species of amphibians and reptiles have been reported in the area (USBR 1974).

7.2 Environmental Impacts - American River

A. **No Action Alternative.** The riparian and other habitat areas, and the associated wildlife species, will likely experience a reduction in numbers and diversity when contracted diversions are realized and flows are reduced. Periodic flooding would likely result in bank erosion and loss of riparian vegetation (USFWS 1987).

B. 100-Year Level of Protection.

1. Increase Lower American River Channel Capacity and Objective Release From Folsom. Under this alternative, approximately 20 miles of levee and bank work would be required to protect against the increased releases. Between 150 and 200 acres of riparian woodlands would be lost under this alternative. The loss of habitat would result in reductions in species abundance and diversity. Further studies would be required during the feasibility phase to quantify anticipated losses and develop appropriate mitigation measures.

2. Increase Flood Control Storage and Objective Release at Folsom Reservoir and Increase Lower American River Channel Capacity. Under this alternative, approximately 10 miles of levee and bank work would be performed along the lower American River, resulting in the loss of between 50 and 100 acres of riparian woodlands. The loss of habitat would reduce the abundance and diversity of existing populations of wildlife.

3. Increase Flood Storage and Lower Spillway at Folsom Dam. Under this alternative, limited levee protection would be performed. As a result, little long-term impact to wildlife populations is expected to result.

C. 150-Year Level of Protection.

1. Increase Flood Control Storage and Objective Release and Lower Spillway at Folsom Reservoir and Increase Lower American River Channel Capacity. See 7.2B(1-3) above.

2. Construct New Upstream Flood Detention Dam. Construction of a 420,000 ac-ft flood water detention dam would have impacts similar to those described below in 7.2D(1).

D. 200-Year (or Greater) Level of Protection.

1. Construct New Upstream Flood Detention Dam. A 570,000 ac-ft flood control reservoir would not result in serious long-term impacts to wildlife populations because the existing vegetation would be retained and no significant reduction in the quality or quantity of habitat is expected. Since the area would be in public ownership, opportunities for wildlife enhancement would be possible. The area would be subjected to periodic temporary inundation approximately once every 10 years, however, it is expected that this situation would be similar to that which was experienced when the Auburn cofferdam was in place. The duration of the inundation is expected to be less than two weeks and reservoir filling would be gradual enough to permit the temporary migration of most wildlife from the flood zone. Mortalities could occur to black bear and western gray squirrel, which are inactive during very cold winter periods.

2. Construct New Upstream Small Multipurpose Reservoir. The direct impact from a small Auburn Dam project would be permanent inundation of up to 4,000 acres of habitat and 37 miles of stream. Wildlife losses resulting from a small Auburn Dam would be considerably less than from a large dam. Depending on the operation plan for the small dam alternative, opportunities for wildlife enhancement would be possible (USFWS 1986).

3. Construct New Upstream Large Multipurpose Reservoir. The large reservoir plan, with a total capacity of 2.3 million acre-feet, would result in the greatest detrimental impacts to wildlife. Water would inundate 10,000 acres of wildlife habitat and eliminate over 47 miles of river channel. Extensive documentation exists on the likely impacts to wildlife resulting from construction of a large Auburn Dam (USFWS 1963, 1976, 1984) and the reader is directed to these sources for additional information.

7.3 Affected Environment - Natomas Area.

The Natomas area has three distinct vegetation types that support the wildlife. These are wooded riparian-wetland, non-wooded wetland, and agricultural areas. The riparian areas occur

in narrow belts along the canal banks. There are several well developed riparian stands containing the cottonwood/willow vegetative association in the Natomas area, such as, Fisherman's Lake, portions of the West Drainage Canal, and scattered sites along the Natomas East Main Drainage Canal. Sites at Del Paso Road and near Interstate 80 contain numerous large valley oaks as well. There is also a large marshy riparian area northeast of the Sacramento Metropolitan Airport along Power Line Road. There are additional riparian areas south of Del Paso Road and west of the East Main Drainage Canal (City of Sacramento 1985).

The Natomas area is a flyway for migrating waterfowl. In the winter months these birds number in the thousands. Red-tailed and marsh hawks are numerous, and white-tailed kites are regularly reported. The barn owl count in the Natomas area indicates high densities. Swainson's hawk and peregrine falcon have also been sighted in this area. The riparian areas provide stopovers for migrant song birds, communal roosts for black-crowned night herons and black-shouldered kites, and roost sites for barn owls and great horned owls. Many other birds that find food in the surrounding open areas nest in the riparian areas. Carnivores, such as the gray fox and ringtail cat, also use the riparian areas for cover and feeding (City of Sacramento 1985).

The non-wooded wetland areas, including marshes, farm ponds and patches of cattails and bulrushes, provide significant wildlife habitat. Birds, like the great blue heron, green-backed heron, pied-billed grebe, belted kingfisher, common yellow-throat, and song sparrow occur in these areas. The giant garter snake has also been sighted in the marshlands of the Natomas area. The most extensive remaining area of natural marsh occurs along Fisherman's Lake. This area is of great value due to its proximity to large trees used for perching, roosting and nesting by birds which feed in the marshes (City of Sacramento 1985).

A large part of the Natomas area is used for rice production. Although this habitat is highly modified, when flooded it is still important to wildlife, shorebirds, and waterfowl, serving as an alternative to natural marshlands. Because the rice fields are close to the Yolo Bypass and in a central position between northern and southern refuges, they are an important feeding and resting habitat for migrating and wintering waterfowl. The Sacramento Audubon Society (1981) has recorded a great variety of ducks, geese, and swans in the area, with many species numbering in the thousands. Great egrets, American bitterns, northern harriers, black-neck stilts, American avocets and other wading birds are also often attracted to these rice fields. The giant garter snake may also use the rice fields, but not as often as the permanent canals (City of Sacramento 1985).

Although wildlife generally prefer natural habitats, pastures and croplands have limited habitat value. Grazed pastures in the Natomas area provide habitat for grassland animals such as turkey vultures, red-tailed hawks, black-shouldered kites,

northern harriers, American kestrels, burrowing owls, mourning doves, ring-necked pheasants, western king birds, loggerhead shrikes, Beechy ground squirrels, black-tailed jackrabbits, and coyotes. Corn, wheat and other grain crops provide food and nest sites for waterfowl, pheasants, various small birds and mammals, and reptiles.

7.4 Environmental Impacts - Natomas Area.

A. No Action Alternative. The wooded and non-wooded riparian-wetland habitats and the associated wildlife species are likely to decline as urbanization and/or agricultural development increases.

B. 100/200 Year Level of Protection.

1. Construct Levees with Gated Structure and Pumping Station at Natomas Cross Canal. A gated structure and pumps are proposed for the Natomas Cross Canal to prevent intrusion of Sacramento River water and to pump canal waters into the Sacramento River. Primary impacts include removal of riparian vegetation at the mouth of the Natomas Cross Canal, resulting in the loss of wildlife habitat in that area. In addition, any levee requiring enlargement and/or reinforcement would result in the temporary removal of herbaceous vegetation that could adversely impact wildlife.

Significant secondary impacts would result as the entire 53,000 acres of the Natomas area is provided increased levels of flood protection. It is inevitable that more development will occur as the flood risk is lowered, causing a loss of agricultural and riparian lands utilized by wildlife. Additional studies are necessary to determine the magnitude of the habitat loss and the appropriate mitigation measures.

2. Construct Cross Levee at Del Paso Road. Construction of a cross levee along the Del Paso Road alignment would result in minor primary permanent impacts to wildlife that presently use the agricultural fields. Because of the reduced area involved under this alternative, it is expected that impacts would be less than those of the other levee alternatives.

Significant secondary impacts to wildlife would occur as the 25,000 acres south of the levee are provided higher levels of flood protection, resulting in increased urbanization and a diminution of wildlife habitat.

3. Construct Cross Levee at Elverta Road. Construction of a cross levee along the Elverta Road alignment would result in minor primary permanent impacts to wildlife that presently use the agricultural fields. It is likely that impacts resulting from this alternative would be less than those for the first levee alternative (7.4B(1)) due to the reduced area of impact.

Significant secondary impacts to wildlife would occur as the 36,000 acres south of the levee are provided higher levels of flood protection, resulting in increased urbanization and a diminution of wildlife habitat.

8.0 WILD AND SCENIC RIVERS

8.1 Lower American River

In 1980, Governor Brown petitioned the Secretary of the Interior to include certain river segments of the California Wild and Scenic Rivers System, including 23 miles of the lower American River from Nimbus Dam to its confluence with the Sacramento River, as components of the National Wild and Scenic Rivers System. On January 19, 1981, the Secretary of the Interior included the lower American River, as well as four other river segments, into the national system (Heritage Conservation and Recreation Service-HCRS, 1980). The lower American River was considered eligible for inclusion into the national system under the recreational river classification on the basis of its "outstandingly remarkable" recreation and anadromous fisheries values.

Under Section 7(a) of the National Wild and Scenic Rivers Act, agencies and departments of the U.S. government are prohibited from assisting by loan, grant, license, or otherwise in the construction of a water resource project which has a direct and adverse effect on the values for which the rivers were established. Under the provisions of the final environmental impact statement and record of decision, HCRS (1980) determined that neither continued maintenance of the lower American River levee system nor proposed water development facilities upstream of the lower American River would conflict with existing recreational and fisheries uses. HCRS (1980) did, however, determine that the planned operation of the Auburn-Folsom South Unit would conflict with recreation and fisheries values since minimum flows down the lower American River would be inadequate to maintain those values.

Potential flood control activities on the lower American River would be inconsistent with the recreation status of the river if they were to reduce discharges into the stream to a rate less than required to maintain the existing recreational and/or fishery values. Measures, such as levee modifications, could create physical disturbances to the river such that significant degradation of habitat and/or esthetic value would result.

8.2 Upper American River

In addition to the recreation designation of the lower American River, approximately 38.3 miles of the North Fork of the American River, extending from 0.3 miles above Heath Springs downstream to a point near the Colfax-Iowa Hill Bridge, was included into the National Wild and Scenic Rivers System by Congressional action in 1978. This reach was designated as a wild river. The flood control measures detailed in this report would not impact this reach.

In addition to the Wild and Scenic River designation of portions of the North Fork, the Planning and Conservation League Foundation (Haines and Cooley 1984) is proposing that a segment of the North Fork and the Middle Fork be established as a National Recreation Area.

Further analysis will be necessary to quantify adverse impacts of the various alternatives. When the alternatives are more fully developed, the Corps will initiate formal consultation under Section 7(a) of the Wild and Scenic Rivers Act with the National Park Service for a "determination of effect" of the refined alternatives.

8.3 Natomas Area

There are no Wild and Scenic River segments in the Natomas area.

9.0 RARE, THREATENED, AND ENDANGERED SPECIES AND HABITATS

9.1 General. The American River watershed comprises many different climatic conditions, topography, and biological features. The diversity of plant and animal life between the boundaries of the watershed is great. Many unique species are specifically dependent on portions of the study area for survival. Human modification and use of these areas has caused the decline and extinction of native species.

9.2 Upper American River. The Upper Basin area consists of habitats that range from foothill grasslands to lodgepole-fir forests. While this area has been subject to extensive logging and mining, there are few threatened and endangered species present.

The bird species of special concern that are known to nest or forage in this area include: the southern bald eagle (Haliaeetus leucocephalus, Federal Status: Endangered, State Status: Endangered); the spotted owl (Strix occidentalis); Swainson's hawk (Buteo swainsoni, Federal Status: Candidate 2, State Status: Threatened), and the peregrine falcon (Falco peregrinus anatum, Federal Status: Endangered, State Status: Endangered).

Uncommon plant species within the watershed include: the Stebbins morning glory (Calystegia stebbinsii, Federal Status: Candidate 2, State Status: Endangered); the Pine Hill flannel bush (Fremontodendron decumbens, Federal Status: Candidate 2, State Status: Rare); Layne's butterweed (Senecio layneae, Federal Status: Candidate 2, State Status: Rare); El Dorado County mule ears (Wyethia reticulata, Federal Status: Candidate 2); Pine Hill ceanothus (Ceanothus roderickii, Federal Status: Candidate 2, State Status: Rare); Red Hills soaproot (Chlorogalum grandifolium, Federal Status: Candidate 2, State Status: Rare); El Dorado bedstraw (Galium californicum sierrae, Federal Status: Candidate 2, State Status: Rare); Bisbee Peak rushrose (Helianthemum suffrutescens, Federal Status: Candidate 2); and, Nissenan manzanita (Arctostaphylos nissenana).

9.3 Lower American River. The Lower American River segment of the investigation includes the American River Parkway. The parkway contains riparian woodland that are considered critical habitat for the valley elderberry longhorn beetle (Desmocerus californicus dimorphus, Federal Status: Threatened). The Swainson's hawk and Sacramento (or sticky) orcutt grass (Orcuttias viscida, Federal Status: Candidate 1, State Status: Endangered) are also found in limited numbers. A western yellow-billed cuckoo (Coccyzus americanus occidentalis, State Status: Threatened) was sighted near the Sailor Bar area of the American River Parkway.

9.4 Natomas Area. The giant garter snake (Thamnophis couchi gigas, Federal Status: Candidate 2, State Status: Threatened) is also known to inhabit the Natomas area. Rapid destruction of the snake's habitat in southern Sacramento County, coupled with development pressures in the Natomas area limit the populations of this species in the Sacramento area. The valley elderberry longhorn beetle has also been found in the Natomas area.

Coordination with the Endangered Species Offices of the U.S. Fish and Wildlife Service (ESO) has been initiated. Complete listings of sensitive species known to inhabit the investigation area are included as Attachment AA. This information will assist us in the analysis of potential effects of different flood control measures, both separately and in combination. In compliance with Section 7 of the Endangered Species Act, as amended, this analysis will be reviewed by ESO during consultation.

10.0 RECREATION

10.1 Affected Environment - American River

The American River watershed offers a variety of recreational opportunities that are unique and nationally significant.

The upper basin of the watershed is used for canoeing, kayaking, rafting, hiking, backpacking, fishing, hunting, swimming, sunbathing, bicycling, camping, snow skiing, gold panning and dredging, jogging, motorcycle trail riding, nature/history study, photography, sight-seeing, snorkeling, and spelunking. The Middle Fork canyon is used for the annual, 100-mile Western States Foot and Tevis Cup horse races (Haines and Cooley 1984).

The lower American River contains a recreation and open space greenbelt that meanders 23 miles through the Sacramento urban area. The presence and size of this greenbelt in a metropolitan area is unique in the United States. The importance of this feature is reflected in recreation use intensity. The American River Parkway has approximately 5,520,000 user-days annually, which is greater than either Yellowstone or Yosemite National Parks (Gold 1985).

Recreational activities in the Parkway vary from high intensity sports, such as baseball or camping, to passive types, such as nature study or bird watching. Water-oriented activities include swimming, fishing, boating, water skiing, and rafting. Hiking, horseback riding, bicycling, and picnicking are activities that are not water dependent, but are enhanced by the presence of the riverine environment. Although golf course development is not presently prohibited by parkway guidelines, two golf courses (one private and one public) were "grand-fathered" into the Parkway at its inception (Nance and Ueda 1977).

10.2 Environmental Impacts - American River

A. No Action. Under the no action alternative, it is expected that recreation and recreational opportunities will decrease as a result of increased water diversions permitted by Decision 893 (D-893) of the California Water Quality Control Board.

B. 100-year Level of Protection

1. Increase Lower American River Channel Capacity and Objective Release From Folsom Reservoir. Increasing the channel capacity to 180,000 cfs would require the placement of up to 20 miles of riprap along the river banks. This, along with the removal of extensive stands of riparian woodlands, would greatly impair the esthetic quality of recreation along the lower

American River. Because the river was included into both the state and Federal Wild and Scenic River systems on the basis of its recreational status, consultation with the National Park Service and the California Resources Agency will be necessary to assess potential impacts of project implementation on the river's protected status.

2. Increase Flood Control Storage and Objective Release at Folsom and Increase Lower American River Channel Capacity. See 10.2b(1) above.

3. Increase Flood Storage and Lower Spillway at Folsom Dam. Increasing the protection of the levees by the placement of riprap should have no long-term impacts on recreation. The crown of the levees are used for bike, equestrian, and hiking trails and those activities would be impacted during construction.

C. 150-Year Level of Protection

1. Increase Flood Control Storage and Objective Release and Lower Spillway at Folsom and Increase Lower American River Channel Capacity. See 10.2B(1-3) above.

2. Construct New Upstream Flood Detention Dam. See 10.2D(1) below.

D. 200-Year (or Greater) Level of Protection

1. Construct New Upstream Flood Detention Dam. No significant change to the current recreation

use is expected as a result of implementation of this alternative.

2. Construct New Upstream Small Multipurpose Dam. See 10.2D(3) below.

3. Construct New Upstream Large Multipurpose Dam.

The recreational impacts of an Auburn reservoir are dependent on the size and location of the structure. The placement of the dam in the American River Canyon would inundate and eliminate all instream recreation within the gross pool area. Recreational opportunities in and along 47 miles of Middle and North Forks would be lost. Uses such as rafting, river fishing, kayaking, gold panning and dredging, and spelunking would be eliminated in the area of inundation. The multipurpose reservoir would, however, substitute lower quality reservoir fishing for the present 20,000 annual (riverine) angler days. Limited power boating and water skiing opportunities would also be created.

A large reservoir could enhance future recreation in the lower American River by providing additional flows for rafting and fishing.

10.3 Affected Environment - Natomas Area

No recreation data is available.

11.0 CULTURAL RESOURCES

11.1 Affected Environment - American River

Prior to European contact, the American River watershed was occupied by the Nisenan (Southern Maidu) Indians. They were related by language to other Indian groups in the Central Valley and Sierra Nevada foothills. Archeological excavations have shown that people either ancestral or similar to the Nisenan have been in the area for at least 4,000 to 5,000 years. Over 100 Nisenan village names were recorded along the major stream drainages from the Yuba River in the north to the Cosumnes River to the south. The epidemics of 1833-1836, and later the Gold Rush, with its influx of settlers, were all significant factors in the rapid demise of the Nisenan people. Today, the archeological remnants of Nisenan culture includes village sites, camp sites, rock art, seed grinding stations (bedrock mortars), hunting blinds, trails, and quarries.

Subsequent to the discovery of gold in 1848 and the arrival of thousands of miners into the area, the American River, as well as other streams in the area, were subjected to many reclamation and development projects. Levees constructed to contain the river, ditches for diverting water, an extensive transportation system (including roads paralleling and crossing the river), as well as a tremendous expansion of ranching and agriculture, characterized the 1850's and decades beyond. Unlike the Sacramento River, river traffic up the American River was usually limited to high flow periods when steamers and others vessels could navigate for a few miles upstream. A map of Sacramento County published in 1894 shows most of the land along both rivers were under extensive agricultural use.

Several cultural resources surveys along the American River from Nimbus Dam to the mouth of the river have been completed on the lower American River. Twenty prehistoric archeological sites have been located either within or immediately adjacent to the American River Parkway boundaries (County of Sacramento 1978). One of these sites also contains remnants of an historic homestead. Several of the sites have been destroyed, either through stream erosion or by construction activities. Excavations have been undertaken at some sites, partly for research, but principally because of impending development. The reports are on file with the State Historic Preservation Officer and the North Central Information Center at California State University at Sacramento. The findings show a long occupation of the American River prior to the historic period. Some of the sites were major villages, others were smaller, perhaps subsidiary to the larger.

Two of the sites are on the National Register of Historic Places. None of the remaining sites have been evaluated for inclusion into the National Register.

There are no recorded historic archeological or historic resources other than the one associated with the prehistoric site.

Historical studies have found a number of fords, ferries, and bridges that were utilized in crossing the river beginning in 1849. The first railroad bridge was constructed in 1862-63, and the Central Pacific Railroad bridge was constructed in 1894. In 1850, a levee three feet high was built along the river from Sacramento two and one-half miles upstream. It was enlarged in 1853. No remains of these earlier modes of transportation are known although their locations have been identified. Because of extensive modification to the river, including channelizing with levees and replacement with modern thoroughfares, it is doubtful that any evidence of earlier bridge abutments, cable crossing, etc. would remain today. The Jibboom Street bridge, near the confluence of the Sacramento and American Rivers, was built in 1929 and remains intact.

The USBR (1972, 1974, 1980), in conjunction with the University of California at Davis, performed extensive archeological studies of the Auburn Reservoir area (USBR 1972, 1974, 1980). Within the project land acquisition line, approximately 1,689 historic sites, and 189 prehistoric sites have been recorded. These data indicate that the Auburn-Folsom area was occupied as early as the Early Central California Horizon (3,000 B.C. - 1,000 B.C.) by the Nisenan or Southern Maidu Indians.

11.2. Environmental Impacts - American River

It is likely that construction activities associated with levee modification and bank stabilization required for increasing the channel capacity on the lower American River could disturb known and unknown cultural resources and, thus, have significant impacts on those resources. If these alternatives are selected for further study during the feasibility stage, the existence of known cultural resource sites will be checked against updated project plans to determine what specific sites could be impacted. In addition, cultural resource surveys, as described in Section 11.5 below, will be conducted to identify unknown resources.

At the sites of the proposed Auburn Dam and Reservoir, USBR (1980) estimated that construction of the 2.3 million ac-ft reservoir would inundate 21 prehistoric sites along the Middle Fork, 20 prehistoric sites on the North Fork above its confluence with the Middle Fork, and 3 prehistoric sites on the North Fork downstream from its confluence with the Middle Fork. In addition, twenty-two historic sites would be inundated (USBR 1972).

If an alternative is selected that involves inundation of the Auburn Dam site, coordination with the State Historic Preservation Officer (SHPO) and the President's Council on Historic Preservation (ACHP) will be necessary to determine the

significance of recorded sites and eligibility for inclusion in the National Register of Historic Places. Further investigations will be required to determine the number of sites that would be impacted through implementation of smaller reservoir alternatives, and impacts resulting from periodic inundation of the prehistoric and historic sites from a dry dam alternative.

11.3 Affected Environment - Natomas Area

Based on previous cultural resource surveys in which prehistoric and historic sites were discovered, the City of Sacramento (1987) has listed sections of both the North and South Natomas areas as archeological sensitive areas.

11.4 Environmental Impacts - Natomas Area

At this time, it is not known whether any of the project alternatives developed for the Natomas area would impact known resources. However, if a flood control alternative for the Natomas area is selected for detailed study during the feasibility phase, surveys and coordination, as described in Section 11.5, will be performed.

11.5 Future Cultural Resources Actions

In future planning stages, intensive cultural resources surveys will be undertaken to identify historic and archeological sites within the project areas selected for further study. Sites will be evaluated for eligibility to the National Register of Historic Places. Coordination with the State Historic Preservation Officer and the President's Council on Historic Preservation will commence under the Section 106 process, as required by the National Historic Preservation Act of 1966, amended 1980. For those sites considered eligible to the National Register, preservation and/or mitigation measures will be developed in consultation with the SHPO, ACHP, and other interested parties. Mitigation/preservation measures will likely range from avoidance of the sites to data recovery through archival research and excavation. Up to one percent of total Federal project funds may be utilized for this purpose after the project is authorized by Congress for construction.

12.0 LAND USE

12.1 Affected Environment - American River

Sites along the lower American River proposed for levee modification are contained within the Central City area (Downtown); East Sacramento Area; Arden-Arcade Area, extending into the City of Carmichael (North Sacramento); Natomas Area, and areas of Sacramento County. The flood plains do not include all areas within these planning areas. The areas of Arden-Arcade, Central City, and East Sacramento are very highly developed (96-97 percent). The principal land uses in the Arden Arcade area are public (schools, transportation and utilities, public/quasi-public, and water), which accounts for over 1,000 acres (City of Sacramento 1987). Much of this acreage is contained within the Cal Expo grounds. Other major land uses include residential development (687 ac), and office developments. The Central City land use is principally public (1,360 ac), followed by residential (965 ac), heavy warehousing (552 ac), office development (464 ac), and commercial development (420 ac) (City of Sacramento 1987). The East Sacramento area is dominated by residential development (2,589 ac), followed by public (725 ac) and parkland/ open space (435 ac). The City of Sacramento (1987) projects that at buildout in the year 2016, the land use acreages will increase slightly to account for the total loss of vacant lands, however, no major change in land use is expected.

The combination of these three areas is expected to capture approximately 2.4 percent of the city-wide population growth between 1985 and 2016, and increase from the present combined population of approximately 83,534 to 88,697. This low percentage growth until buildout is due to the highly developed nature of the area at present (City of Sacramento 1987).

Land use patterns of the proposed Auburn Dam site, and projected impacts resulting from project implementation, have been described by the U.S. Bureau of Reclamation (1972, 1974, 1980).

12.2 Environmental Impacts - American River

Due to the highly developed nature of the area adjacent to the levee system, failure could result in catastrophic flooding with high loss of life and high levels of property damage.

It is not expected that land uses in either the American River Parkway, the Arden-Arcade, Central City, or East Sacramento areas would change as a result of flood control improvement. Because the area has been determined to have flood protection below the 100-year level, it is conceivable that the rate of growth may be retarded as lenders and buyers become reluctant to assume additional flooding risks. Flood control improvements are

TABLE 13

NEW UPSTREAM RESERVOIR - REQUIRED FLOOD CONTROL SPACE
(1,000 ac-ft)

Level of Protection (Return Period - yrs) <u>1/</u>	Total Flood Storage	Folsom Flood Storage <u>2/</u>	New Upstream Flood Storage
63 (existing)	400	400	0
100	585	300 <u>3/</u>	285
100	600	400	200
110	650 <u>4/</u>	300 <u>3/</u>	350
150	800	400	200
200	900	300 <u>3/</u>	600
200	940	400	540
200	1,010	500	510
250	920	300 <u>3/</u>	620

1/ Along mainstem American River.

2/ Includes maintaining objective release from Folsom at 115,000 cfs.

3/ Except for existing, assumes 100,000 ac-ft of Folsom flood storage will be transferred upstream to new reservoir.

4/ Flood control space for authorized Auburn project.

As can be seen in the above table, the total flood space required for a specific level of flood protection is influenced by the amount of flood space considered in Folsom Reservoir. This is primarily because transfer of space from Folsom to a new upstream site would allow a more effective system operation for flood control. Also, studies have indicated that the least amount of total flood space that should be considered in Folsom is 300,000 ac-ft. Flood runoff in the American River Basin is about evenly split among the three main river forks (North, Middle, and South Forks). Accordingly, this translates to a runoff on the order of 300,000 ac-ft directly to Folsom and 600,000 ac-ft to the Auburn site. Also, Folsom Dam can operate to the objective release of 115,000 cfs more effectively with a stage in the reservoir corresponding to 300,000 ac-ft than 400,000 ac-ft of flood control space.

Potential reservoir sites in the Upper American River Basin are listed in Table 14 and shown on Plate 9. The most practical location for an upstream reservoir with a storage capacity large enough to provide flood space necessary to significantly reduce downstream floodflows seems to be on the

The City of Sacramento (1987) projects that at buildout, the principal land use will be residential (4,002 ac), followed by industrial (2,386 ac), parklands/open space (1,650 ac), office (507 ac), other (500 ac), agricultural (190 ac), and commercial (170 ac).

The population of the North Natomas area in the City of Sacramento is expected to capture 31.6 percent of the city-wide population growth from 1985 to 2016, and increase from 843 to 69,056 persons (City of Sacramento 1987).

The area within Sacramento and Sutter Counties encompasses approximately 37,700 acres. The Sacramento Metropolitan Airport, and approximately 2,000 acres of airport related industrial land, are included in this area. Land uses are mainly agricultural, with public and private uses, including industrial development and vacant lands. The developed areas include Metro Airport, Natomas Air Park, the Natomas Sewer Treatment Pumping Station, and low density residential areas.

12.4 Environmental Impacts - Natomas Area

Land use in the Natomas area is expected to continue to evolve from principally agricultural uses to non-agricultural developments. The Natomas area is expected to continue to be the major area of residential development in the City of Sacramento for the next thirty years.

Improvement in the level of flood protection to the Natomas area will likely induce growth as lenders and buyers are assured of higher levels of flood protection. The increased level of flood protection will facilitate the land use changes approved by the City of Sacramento (1987).

The level and rate of growth are dictated by local land use policies, however, these policies would be governed, in part, by the flood control alternative selected. Greater levels of development would be possible under the Gated Structure/Pumping Plant alternative since a much larger area would be available for potential development. Selection of the Del Paso Cross Levee alternative would basically protect the existing development in the South Natomas area and a small portion of the North Natomas area.

13.0 PUBLIC SCOPING PROCESS

Two technical scoping meetings were conducted by the Sacramento District to ensure public participation in the preparation of this environmental assessment, and to identify concerns and questions regarding potential environmental effects of the various flood control alternatives. These meetings were attended by representatives of federal, state, county, and city environmental resources agencies, and by representatives of concerned environmental groups.

The Sacramento District also participated in Special Congressional Hearings conducted by Congressmen Vic Fazio, Robert Matsui, and Norman Shumway, and other state and local representatives to examine flood control and water resources needs of the Sacramento area. The district made presentations at two hearings, in which the need for flood control was evaluated and potential measures described.

In addition, the Sacramento District conducted a field trip for the staffs of elected representatives and environmental groups in which the various alternatives and potential environmental impacts were detailed.

14.0 FISH AND WILDLIFE COORDINATION

The U.S. Fish and Wildlife Service (1987) submitted a Planning Aid Letter to the Sacramento District, which provided information on biological resources within the study area, assessment of impacts of the various alternatives, a relative rating of alternative preference, and recommendations for future studies necessary to fully assess potential impacts (see Attachment BB).

15.0 FINDINGS

Full assessment of the environmental impacts of the proposed flood control measures cannot be completed until the alternatives are more fully developed (sites, sizes, operational scenarios, etc.). However, based upon the alternatives presented and the sensitive environmental resources within the project area, it is apparent that without the provision for effective mitigation features, implementation of the following alternatives would generate significant adverse impacts:

American River

1. Increase Lower American River Channel Capacity and Objective Release From Folsom Dam (100-Year Level of Protection).
2. Increase Flood Control Storage and Objective Release at Folsom and Increase Lower American River Channel Capacity (100-Year Level of Protection).
3. Increase Flood Control Storage and Objective Release at Folsom, and Lower Spillway at Folsom and Increase Lower American River Channel Capacity (150-Year Level of Protection).
4. Construct New Upstream Small Multipurpose Reservoir. (200-Year or Greater Level of Protection).

5. Construct New Upstream Large Multipurpose Reservoir. (200-Year or Greater Level of Protection).

Two alternatives appear at this early planning phase to have relatively low levels of environmental impact. These are:

1. Increase Flood Storage at Folsom and Lower Spillway.
2. Construct New Upstream Flood Detention Dam.

Natomas Area

It is likely that the removal of vegetation, disturbance to wildlife habitat and cultural resources, and secondary growth-inducing impacts (air quality, social impacts) resulting from implementation of the Natomas flood control alternatives could have significant environmental impacts.

Conclusions

Therefore, based on the preliminary assessment of significant impacts to the human environment resulting from implementation of flood control alternatives for the lower American River and Natomas areas, it will be necessary to prepare an environmental impact statement during the feasibility study phase for alternatives selected for detailed study.

Future studies that are believed necessary to prepare an environmental impact statement and determine suitable mitigation are dependent on which alternatives that are selected for further study.

Structural modifications to the lower American River levee system may require the following studies:

1. surveys of terrestrial vegetation and wildlife, including HEP analyses, along the lower American River.
2. inventory of valley elderberry longhorn beetle habitat at the potential construction sites.
3. surveys for cultural resources.

Upstream storage alternatives may require the following studies:

1. surveys of terrestrial vegetation and wildlife, including HEP analyses, within the American River canyon.
2. determination of flood tolerance of plants in Auburn Dam area.
3. cultural resource surveys.

4. recreation use study.

Natomas area flood control alternatives may require the following studies:

1. surveys of terrestrial vegetation and wildlife, including HEP analyses, along affected waterways and canals.
2. inventory of potential valley elderberry long-horned beetle habitat.
3. cultural resource surveys.

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20.0 LIST OF PREPARERS

<u>NAME</u>	<u>DISCIPLINE/EXPERTISE</u>	<u>EXPERIENCE</u>	<u>ROLE IN PREPARING EA</u>
John Bissell	Geographer	Corps of Engineers. Independent Research, 4 Years	Research Assistant
Dave Gundiach	Civil Engineer Water Resources Planning Hydraulics and Hydrology	Water Resources Related Activities, Corps of Engineers, 15 Years	Project Engineer, Plan Formulation
Patti Johnson	Archeologist	Archeological Consultation, 10 Years Corps of Engineers, 15 Years	Cultural Resource Report
Donna Kim	Civil Engineer	Corps of Engineers, 2 Years	Plan Formulation
Fred Kindel	Environmental Planner, Wildlife Management	Corps of Engineers, 23 Years, State and Private Wildlife Management, 7 Years	Report Review
Richard Meredith	Environmental Analysis, Aquatic Biology	Corps of Engineers, 9 Years, Nat. Mar. Fish. Ser., 1 Year	Study Manager, Report Preparation
Michele Ng	Civil Engineer	Corps of Engineers, 2 Years	Plan Formulation, Report Review
Steve Peterson	Physical Geographer	Corps of Engineers, 4 Years, Calif. DWR, 2 Years, Private Consulting, 1 Year	Study Manager, Report Preparation
Merritt Rice	Civil Engineer, Water Resources Planning	Corps of Engineers, 12 Years	Project Engineer, Plan Formulation
Jane Rinck	Environmental Studies, Geography	Corps of Engineers, 1 Year, Independent Research, 1 Year	Research and Analysis
Lynne Stevenson	Technical Writer, Editor	Corps of Engineers, 3 Years Library Work, 10 Years	Report Review and Editing
Mike Welsh	Environmental Planner, General Biology	Corps of Engineers, 11 Years	Report Preparation and Review



United States Department of the Interior

FISH AND WILDLIFE SERVICE

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AUG 04 1987

In Reply Refer To:
JW/1-1-87-SP-508

Mr. Walter Yep
Chief, Planning Division
U.S. Army Corps of Engineers
650 Capitol Mall
Sacramento, California 95814-4794

Subject: List of Endangered and Threatened Species in the
American River Watershed

Dear Mr. Yep:

As requested by letter from your agency dated July 2, 1987, you will find attached a list of listed endangered and threatened species (Attachment A) that may be present in the area of the subject project. To the best of our knowledge no proposed species occur within the area. The list is intended to fulfill the requirement of the Fish and Wildlife Service to provide a list of species under Section 7(c) of the Endangered Species Act, as amended. Please see Attachment B for your requirements.

Also for your assistance, we have included a list of candidate species. These species are presently being reviewed by our Service for consideration to propose and list as endangered or threatened. Candidate species have no protection under the Endangered Species Act and are included for your consideration as it is possible the candidates could become formal proposals and be listed during the construction period.

Upon completion of the Biological Assessment (see Attachment B), should you determine that a listed species is likely to be affected (adversely or beneficially), then your agency should request formal Section 7 consultation through our office at the letterhead address. If there are both listed and candidate species (if included in the assessment) that may be affected and if requested, we will informally consult on the candidate species during the formal consultation. However,

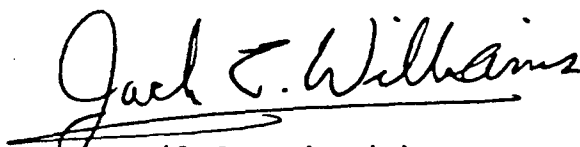
should the assessment reveal that only candidate species may be affected, then you should consider informal consultation with our office at the letterhead address.

One of the benefits of informal consultation to the consulting agency is to provide the necessary planning alternatives should a candidate species become listed before completion of a project. Informal consultation may also be utilized prior to a written request for formal consultation to exchange information and resolve conflicts with respect to listed species.

If the Biological Assessment is not initiated within 90 days of receipt of this letter, you should informally verify the accuracy of the list with our office.

Should you have any additional questions regarding this list or your responsibilities under the Act, please contact Dr. Jack Williams at (916) 978-4866 or (FTS) 460-4866. Thank you for your interest in endangered species, and we await your assessment.

Sincerely,


For Gail C. Kobetich
Field Supervisor

Attachments

cc: Chief, Endangered Species, Portland, Oregon (FWE-SE;
Attn: Ralph Swanson)
Field Supervisor, Ecological Services, Sacramento,
California (ES-S)

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES AND
CANDIDATE SPECIES THAT MAY OCCUR IN THE AREA OF THE
AMERICAN RIVER WATERSHED, CALIFORNIA
(Case No. 1-1-87-SP-508)

Listed Species

Birds

Bald eagle, Haliaeetus leucocephalus (E)
(nests at Union Valley Reservoir and winters at other
reservoirs)

Insects

Valley elderberry longhorn beetle, Desmocerus
californicus dimorphus (T)
(occurs along the American River below Folsom)

Plants

Truckee barberry, Berberis sonnei (E)

Proposed Species

None

Candidate Species

Birds

Swainson's hawk, Buteo swainsoni (2)
(also state-listed as threatened)

Reptiles

Giant garter snake, Thamnophis couchi gigas (2)
(also state-listed as threatened)

Plants

Pleasant Valley mariposa, Calochortus clavatus var.
avius (1)
Stebbins' morning-glory, Calystegia stebbinsii (2)
hispid bird's-beak, Cordylanthus mollis subsp. hispidus
(2)
Cup Lake draba, Draba asterophora var. macrocarpa (2)
El Dorado bedstraw, Galium californicum subsp. sierrae
(2)
Boggs Lake hedge-hyssop, Gratiola heterosepala (2)
legenere, Legenere limosa (2)
saw-toothed lewisia, Lewisia serrata (2)
Stebbins' phacelia, Phacelia stebbinsii (2)
bearded allocarya, Plagiobothrys hystriulus (2)
valley sagittaria, Sagittaria sanfordii (2)
El Dorado mule-ears, Wyethia reticulata (2)

- (E)--Endangered (T)--Threatened (CH)--Critical Habitat
- (1)--Category 1: Taxa for which the Fish and Wildlife Service
has sufficient biological information to support a proposal
to list as endangered or threatened.
- (2)--Category 2: Taxa for which existing information indicated
may warrant listing, but for which substantial biological
information to support a proposed rule is lacking.

ATTACHMENT B

FEDERAL AGENCIES' RESPONSIBILITIES UNDER SECTIONS 7(A) and (c) OF THE ENDANGERED SPECIES ACT

SECTION 7(a) Consultation/Conference

Requires: 1) Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species; 2) Consultation with FWS when a Federal action may affect a listed endangered or threatened species to insure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continue existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the Federal agency after determining the action may affect a listed species; and 3) Conference with FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed critical habitat.

SECTION 7(c) Biological Assessment--Major Construction Activity 1/

Requires Federal agencies or their designees to prepare a Biological Assessment (BA) for major construction activities. The BA analyzes the effects of the action on listed and proposed species. The process begins with a Federal agency requesting from FWS a list of proposed and listed threatened and endangered species. The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the list, the accuracy of the species list should be informally verified with our Service. No irreversible commitment of resources is to be made during the BA process which would foreclose reasonable and prudent alternatives to protect endangered species. Planning, design, administrative actions may proceed; however, no construction may begin.

We recommend the following for inclusion in the BA: an onsite inspection of the area affected by the proposal which may include a detailed survey of the area to determine if the species or suitable habitat are present; a review literature and scientific data to determine species' distribution, habitat needs, and other biological requirements; interviews with experts, including those

1/ A construction project (or other undertaking having similar physical impacts) which is a major Federal action significantly affecting the quality of the human environment as referred to in NEPA (42 U.S.C. 4332(2)C).

within FWS, State conservation departments, universities and others who may have data not yet published in scientific literature; an analysis of the effects of the proposal on the species in terms of individuals and populations, including consideration of cumulative effects of the proposal on the species and its habitat; an analysis of alternative actions considered. The BA should document the results, including a discussion of study methods used, any problems encountered, and other relevant information. The BA should conclude whether or not a listed or proposed species will be affected. Upon completion, the BA should be forwarded to our office.

BALD EAGLE

(Haliaeetus leucocephalus)

CLASSIFICATION:

Endangered (Federal Register 43:633; February 14, 1978).

CRITICAL HABITAT: None designated.

DESCRIPTION:

Next to the California condor, the bald eagle is the largest bird in California with a wingspan measuring 6 to 7 feet. Adults are brownish black with a white head and tail and yellow bill. Immatures are variously brownish black.

DISTRIBUTION:

Bald eagles can and do occur virtually anywhere in California during migration. They nest near water bodies in the northern portion of the state and winter throughout the state wherever suitable prey resources are available.

SPECIAL CONSIDERATIONS:

Although some bald eagle populations began to decline in the 19th century due to human persecution and habitat loss, the drastic declines in reproduction experienced by most eagle populations occurred between 1947 and 1970. Research indicated that certain organochlorine pesticides interfered with productivity, and other pesticides were responsible for direct mortalities. Most bald eagle populations are now stable or increasing in numbers.

REFERENCES FOR ADDITIONAL INFORMATION:

Detrich, P. J. 1986. The status and distribution of the bald eagle in California. M. S. Thesis. Chico State Univ., CA

Frenzel, R. W. 1984. Ecology and environmental contaminants of bald eagles in southcentral Oregon. Ph.D. Thesis. Oregon State Univ., Corvallis, OR.

Lehman, R. N., D. E. Craigie, P. L. Collins, and R. S. Griffen. 1980. An analysis of habitat requirements and site selection criteria for nesting bald eagles in California. Report by Wilderness Research Institute, Arcata, CA for U.S. Forest Service, Region 5, San Francisco, CA.

U.S. Fish and Wildlife Service. 1986. Recovery plan for the Pacific Bald Eagle. Portland, OR.

VALLEY ELDERBERRY LONGHORN BEETLE
(Desmocerus californicus dimorphus)

CLASSIFICATION: Threatened - Federal Register 45FR52803
August 8, 1980.

CRITICAL HABITAT: Federal Register 17.95(c), May 7, 1980.

California. Sacramento County.

(1). Sacramento Zone. An area in the city of Sacramento enclosed on the north by the Route 160 Freeway, on the west and southwest by the Western Pacific railroad tracks, and on the east by Commerce Circle and its extension southward to the railroad tracks.

(2). American River Parkway Zone. An area of the American River Parkway on the south bank of the American River, bounded on the north by latitude 38° 37'30" N, and on the south and east by Ambassador Drive and its extension north to latitude 38° 37'30" N, Goethe Park, and that portion of the American River Parkway northeast of Goethe Park, west of the Jedediah Smith Memorial Bicycle Trail, and north to a line extended eastward from Palm Drive.

(3). Putah Creek Zone. California. Solano County. R 2 W T. 8 N. Solano County portion of Section 26.

DESCRIPTION:

Horn described the Valley elderberry longhorn beetle in 1881 and it was redescribed in 1921 by Fisher. Morphological description: In general, longhorn beetles are characterized by somewhat elongate and cylindrical bodies with long antennae, often in excess of 2/3 of the body length. In contrast, males of VELB are stout-bodied and their elytra (thickened, hardened forewings) are coarsely punctured, with a metallic-green pattern of 4 oblong maculations, surrounded by a bright red-orange border. The border eventually fades to yellow on museum specimens. The maculations are fused on some males, more closely resembling the nominate subspecies. Antennae are about as long as the body or slightly shorter. Body length is about 13-21 mm.

Females are more robust, elytra are subparallel, and the dark pattern is not reduced. Antennae reach to about the middle of the elytra and body length is about 18-25 mm. Both sexes of VELB are readily identified due to their distinctive appearance. As noted earlier, males with fused maculations resemble the nominate subspecies, Desmocerus californicus dimorphus, Fisher, 1921.

DISTRIBUTION:

VELB is endemic to moist valley oak woodlands along the margins of rivers and streams in the lower Sacramento and upper San Joaquin Valley of California, where elderberry (*Sambucus* spp.), its foodplant, grows. During the past 150 years over 90 percent of the riparian habitat in California has been destroyed by agricultural and urban development. Although the entire historical distribution of VELB is unknown, the extensive destruction of riparian forests of the Central Valley of California strongly suggests that the beetle's range may have shrunk and become greatly fragmented.

Due to the limited knowledge about the VELB's life history, and its ecological requirements, precise threats to its survival are difficult to enumerate. Clearly the primary threat to survival of the VELB has been and continues to be loss and alteration of habitat by agricultural conversion, grazing, levee construction, stream and river channelization, removal of riparian vegetation, rip-rapping of shoreline, plus recreational, industrial and urban development. Insecticide and herbicide use in agricultural areas may be factors limiting the beetle's distribution. The age and quality of individual elderberry shrubs/trees and stands as a foodplant for VELB may also be a factor in the beetle's limited distribution.

There is little information on former abundance of VELB for comparison with current population levels. A. T. McClay collected 51 adults during May 1947. Dr. John A. Chemsak, a cerambycid specialist from the University of California, Berkeley, believes that VELB has probably always been rather rare and of limited abundance.

SPECIAL CONSIDERATION:

The riparian habitat of the beetle is still being degraded by urban development and levee repair work along the rivers. There has been some successful elderberry transplantings in specific areas along the rivers. This has increased the viable habitat for the beetle.

Special recovery efforts needed: Protect the only known VELB colonies; conduct further research on life history and habitat requirements of VELB; survey areas in Central Valley of California to locate additional colonies; formulate management plans as appropriate information on VELB's biology becomes available; establish VELB at rehabilitated habitat sites within present-day range; monitor VELB colonies to determine population status and success of management actions as implemented; increase public awareness of VELB through educational and information programs. Studies on the physiological requirements of the beetle and of the elderberry plants are needed.

REFERENCES FOR ADDITIONAL INFORMATION:

- Arnold, R. A. 1984. Interim report for contract C-616 with the California Department of Fish and Game. 14 pp.
- Burke, H.E. 1921. Biological notes on Desmocerus, a genus of roundhead borers, the species of which infests various elders. J. Econ. Ent. 14:450-452.
- Craighead, F.C. 1923. North American cerambycid larvae. A clarification and the biology of North American cerambycid larvae. Can. Dept. Ag., Ottawa. Bull. 27. 239 pp.
- Eng, L.L. 1984. Rare, threatened, and endangered invertebrates in California riparian systems. Pp. 915-919, in R. E. Warner and K. M. Hendrix (eds). California Riparian Systems: Ecology, Conservation, and Productive Management. University of California Press, Berkeley. 1035 pp.
- Eya, B.K. 1976. Distribution and status of a longhorn beetle, Desmocerus californicus dimorphus Fisher (Coleoptera: Cerambycidae). Unpublished ms. 6 pp.
- Jones and Stokes. 1985 and 1986. Survey of habitat and population of the valley elderberry longhorn beetle along the Sacramento River, 1985 Progress Report. 46 pp., A 1 and 2 86 pp.
- Linsley, E. G., and J. A. Chemsak. 1972. Cerambycidae of North America, part No. 1. Taxonomy and classification of the subfamily Lepturinae. University of California publ. Entomol. Vol. 69.
- Western Ecological Services Company (WESCO). Undated. Lower San Joaquin River snagging and clearing project endangered species data report; valley elderberry longhorn beetle (Desmocerus californicus dimorphus). Report submitted to U.S. Army Engineer District, Sacramento. Contract No. DACW05-84-P-1051. 15 pp.
- U.S. Fish and Wildlife Service. 1984. Valley elderberry longhorn beetle recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon. 62 pp.

TRUCKEE BARBERRY

(Berberis sonnei)

CLASSIFICATION: Endangered (44 FR 64246)

CRITICAL HABITAT: None designated.

DESCRIPTION:

Creeping or ascending low shrub, 10-40 cm tall; leaves odd-pinnately compound, 10.5-26.5 cm long and 7.0-13.5 cm wide, with (3-) 5-7 (-9) leaflets; leaflets ovate-elliptic to broadly lanceolate in outline, primarily pinnately to sub-palmately veined, 4.0-8.5 (-11) cm long and 2.2-6.5 cm wide, acute to obtuse at tip and obliquely cuneate to obtuse at base, margins serrate and undulate with (7-) 12-24 (-26) short spines per margin, abaxial surface microscopically (60X) papillate, adaxially glossy to dull-glossy and dull to slightly glossy below; racemes terminal or axillary, 15-45 (-60) mm long, densely yellow flowered; flowers borne on bracteate pedicels 7-8 mm long with an early deciduous prophyll at mid-length (approximately 5% of the pedicels bearing prophylls at anthesis); sepals 6 in two series of three, the outer 3-3.5 mm long, the inner 4.5-5.0 mm long; petals 6 in two series of three, the outer longer, 6-7 mm long, with the inner 5-6 mm long, both petals and sepals deciduous upon maturation of the fruit; stamens 6 opposite the petals; berries blue-black, glaucous, ellipsoid to 6 mm long; flowering mid-April to late May.

DISTRIBUTION:

The only known habitat is a disturbed stream side forest area behind (within 15 m of) houses. The species appears to be restricted to the flood plain of the river, although this may be an artifact of the degree of disturbance above the flood plain. The canopy is fairly open and sporadic in cover, composed of a number of large Populus trichocarpa and less so of Prunus virginiana var. demissa and Salix lutea. One planted contributes to the canopy cover of one of the five patches of the Truckee barberry. Two of the patches have little canopy overstory and are scattered in open exposed areas among grasses and weedy herbaceous species. Rosa woodsii var. ultramontana is common in association with the Truckee barberry. The soil throughout the Truckee population is a rocky sandy loam and exhibits poorly defined horizons (Rogers 1974). It is derived from granitic and volcanic alluvium (Rogers 1974). Annual alluvial deposition onto the site can be considerable depending on the spring snowmelt-induced flooding. The site is highly disturbed from domestic animal burrowing, clearing for garden sites, rubbish dumping, residential development, and recreational use. Intense past human use of the area has likely altered the natural vegetation of the site from one originally dominated by yellow pine/riparian forest to one now

consisting of ruderal species with a remnant wetland forest canopy.

Contrary to an assertion in the recovery plan, the species does appear to require a close association with abundant subsurface water. Their discussion to the contrary was based on the so-called "xeric" site of a transplanted individual of Berberis sonnei (Manonia sonnei) at the Tilden Botanical Garden in Berkeley, California. This site is situated downslope from a watered lawn area and likely has abundant subsurface water available throughout the year. It in no way approaches the xeric sites of the eastern Sierra Nevada and provides no information towards an assessment of the tolerance of the Truckee barberry to drought stress. B. repens, the more xeric barberry of the western U.S., is always topographically associated with drainages or subsurface moisture. A similar situation would be expected for the Truckee barberry.

The species may be adversely impacted by livestock grazing (i.e., horses) if such grazing occurred in the area behind the houses and by the river edge in Truckee. Such use would result in rapid loss of the plants in the area immediately affected.

Considering the intensity of disturbance on this site over the past 130 years, it is difficult to discuss the natural habitat associated with this species. Present disturbance to the site continues and is likely to increase in intensity and degree as economic growth of the Truckee area continues at a rapid pace. New home construction along Riverside Drive has quickened the last 5 years with larger, more elaborate homes being built on the sites of previous small houses (06).

Regarding possible other sites in the Truckee River drainage, it seems likely that any other populations of the species were lost in the recent past. With the development of the Central Pacific (subsequently the Southern Pacific) Railroad in the 1860-70's, followed by large-scale logging flume systems, irrigation systems, highway and then freeway construction down the narrow Truckee River canyon, large-scale extirpation of the species, if it occurred there, would have resulted. Extensive surveys of the side canyons of the Truckee River from Deer Creek downstream to Verdi in 1985 failed to turn up any other populations of the species. One noticeable feature of this watershed observed during the surveys was the degree of disturbance throughout the area, both from direct anthropogenic causes as well as indirectly from man-introduced grazers. Specific grazing by the introduced and successfully naturalized beaver population on shrub and tree species is extremely high. During the early fluctuation period characteristic of introduced animal population, the beaver population of the Truckee and Feather Rivers rose quite high followed by rapid crashes, then rising again. Heavy grazing during this time may have removed all palatable shrubs from within 150-250 m of the river banks. A plant such as B. sonnei which appears to be restricted to river banks or stream systems would have been rapidly decimated. Its only known occurrence in the backyards of a dense housing site, where beavers may have been less

likely to forage far from the safety of the water, may support the idea that grazing was the overall factor in its loss in the watershed.

Other possible habitat associations could include seepage areas or arid riparian sites in the eastern Sierra Nevada and adjacent Great Basin ranges. This is especially true for isolated wet areas in the yellow-pine sagebrush belt extending north into Modoc County, California, and possible adjacent Oregon and Nevada.

SPECIAL CONSIDERATIONS:

Due to considerable taxonomic confusion regarding this species (McMinn 1951, Roof 1974), distribution of this species is difficult to determine. Given our present knowledge and the taxonomic methodology attempted to date, the characters typically used to differentiate B. sonnei and B. repens do not consistently separate these entities when all variation in the latter species is considered. B. repens is a widespread species exhibiting considerable morphological variation throughout its extensive range (California east to Arizona, north to Montana and Alberta, and west to British Columbia and Washington, then south to Oregon and California tending to occur mostly east of the Cascades and Sierran crest). No precise boundaries can be drawn between B. repens and B. aquifolium of the Pacific Northwest. B. repens recently has been reduced to variatal status under B. aquifolium (Scoggan 1978). B. sonnei may represent the intergradation between the two above-mentioned widespread species. Such intergradation is also seen in northern Idaho where clear delimitation of B. repens or B. aquifolium is not possible.

REFERENCES FOR ADDITIONAL INFORMATION:

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- Ahrendt, L. W. A. 1961. Berberis and Mahonia. *J. Linn. Soc.* 57:1-408.
- California Native Plant Society. 1977. [Untitled rare plant status report on Berberis sonnei]. Prep. by T. Neihaus, Berkeley, Calif.
- Edwards, W. F. 1883. Tourists' guide and directory of the Truckee Basin. "Republican" Job print, Truckee, Calif.
- Jones, M. E. 1902. [Introductory remarks on zonal distribution.] *Contr. West. Bot.* 10:2.
- _____. 1965. Botanical exploration of Marcus E. Jones [written ca. 1923-1933]. *Leaflet West Bot.* 10:191-236.
- Lindley, T. 1828. Berberis repens. t 1176 [plate no.]. In Edward's Botanical Register.

- McCain, J. W., and J. F. Hennen. 1982. Is the taxonomy of Berberis and Mahonia (Berberidaceae) supported by their rust pathogens Cumminsia santa sp. no. and other Cumminsia species (Uredinales)? Syst. Bot. 7:48-59.
- McMinn, H. E. 1939. An illustrated manual of California shrubs. Univ. Calif, Press, Berkeley.
- Meacham, C. A. 1980. Phylogeny of the Berberidaceae with an evaluation of classifications. Syst. Bot. 5:149-172.
- Meschery, J. 1978. Truckee: an illustrated history of the town and its surroundings. Rocking Stone Press, Truckee Calif.
- Rogers, J. H. 1974. Soil survey of the Tahoe Basin area, California and Nevada. USDA, Soil Conservation Service.
- Roof, J. B. 1974. Found alive: The Truckee barberry. Four Seasons 4(4):1-18.
- Scoggan, H. J. 1978. The Flora of Canada, Part 1, General survey-nomenclatural changes. National Museum of Natural Sciences.
- Tappe, D. T. 1942. The status of beavers in California. Calif. Dept. of Fish and Game, Game Bull. No. 3. 59pp.
- U.S. Fish and Wildlife Service. 1984. Recovery Plan for the Truckee Barberry [Berberis (=Mahonia) sonnei (Abrams) McMinn]. U.S. Fish and Wildlife Service, Portland, OR. 68pp.



United States Department of the Interior

FISH AND WILDLIFE SERVICE
Division of Ecological Services
2800 Cottage Way, Room E-1803
Sacramento, California 95825

December 18, 1987

Colonel Wayne J. Scholl
District Engineer, Sacramento District
Army Corps of Engineers
650 Capitol Mall
Sacramento, California 95814

Subject: CE - American River Watershed Flood Control Investigation

Dear Colonel Scholl:

This planning aid letter provides information for the American River Watershed Flood Control Investigation. Comments provided herein include input obtained during informal coordination with the California Department of Fish and Game. The information provided is preliminary in nature and provided as technical assistance to aid your planning process. This letter does not constitute the detailed report of the Fish and Wildlife Service as required by Section 2 of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). Our analysis is based on project information provided by the Corps of Engineers prior to November 6, 1987, and supplements our previous planning aid letter dated July 20, 1987.

Our findings are based on site inspections of the lower American River and Natomas areas conducted on October 30, 1987, and the Auburn area on November 16, 1987. Information regarding threatened and endangered species was provided by our endangered species staff. A formal list of threatened and endangered species was provided to you on August 4, 1987.

DESCRIPTION OF THE AREA

The American River is the second largest tributary of the Sacramento River with its headwaters at 10,400 feet elevation (mean sea level) in the Sierra Nevada mountains in central California. The American River consists of the North, Middle and South Forks, and generally flows in a southwesterly direction, descending to 25 feet in elevation at its confluence with the Sacramento River in the City of Sacramento. Annual flow in the American River ranges from 340,000 to 6,381,000 acre-feet and averages 2.7 million acre-feet from its 1,875 square-mile watershed (U.S. Bureau of Reclamation 1987).

The North and Middle Forks of the American River are upstream from Folsom Reservoir, and join near Auburn. It is slightly downstream of the confluence of these two forks where Auburn Reservoir is proposed to be built. The headwaters of the North and Middle Forks begin near Granite

Chief Mountain in Placer County. Both forks flow through narrow, steep canyons dominated by chaparral and woodland vegetation.

DESCRIPTION OF ALTERNATIVES

In February 1986, major storms in Northern California caused record flows in the American River Basin. These flows increased concern about the potential for flooding in parts of the watershed. In January 1987, at Congressional direction, the Corps initiated a reconnaissance level study on flood control in the American River Basin. Preliminary flood control measures were identified by the Corps in June 1987. Several of these have since been dropped from consideration because the Corps determined they were infeasible. Several other measures have since been added to those being considered earlier. The various measures were combined to form several flood control alternatives. This letter discusses our preliminary assessment of fish and wildlife concerns, needed studies, and potential mitigation that may be needed with the flood control alternatives currently under consideration.

Lower American River Alternatives

Seven alternatives were developed for 100-, 150-, and 200-year levels of flood protection along the lower American River.

100-year Flood Protection Level

1. Increase lower American River channel capacity and objective release at Folsom. Under this alternative, the objective release of water from Folsom Dam would be increased from 115,000 cubic-feet per second (cfs) to 180,000 cfs, and extensive levee, river bank, and structural modifications would be constructed to accommodate this flow. These modifications include raising and constructing levees along the American River, Arcade Creek, Yolo Bypass, and the Natomas East Main Drainage Canal; installing approximately 110,000 lineal feet of riprap along the lower American River; and raising or replacing several bridges. Riprap would be installed at up to two-thirds of the existing banks and levees along the river from Discovery Park to Sailor Bar. Also, a new levee would be constructed near Ancil Hoffman Park.

2. Increase flood control storage and objective release at Folsom and increase American River channel capacity. Under this alternative, the maximum designated flood control storage in Folsom Reservoir would be increased from the present 400,000 acre-feet to 630,000 acre-feet, and the objective release from Folsom Dam would be increased from 115,000 cfs to 130,000 cfs. Downstream levee, river bank and structural modifications would be similar to the previous alternative except that only 75,000 lineal feet of riprap would be installed along the American River, and the levees would not be raised as high.

3. Increase flood control storage and lower the spillway at Folsom Reservoir. This alternative involves increasing the maximum flood control

storage space at Folsom Reservoir to 650,000 acre-feet and lowering the five service gates at the spillway by 15 feet.

150-Year Flood Protection Level

4. Increase flood control storage, increase objective release and lower spillway at Folsom Reservoir and increase lower American River channel capacity. Under this alternative, the maximum designated flood control space in Folsom Reservoir would be increased to 620,000 acre-feet, the downstream water release would be increased to 180,000 cfs, and the gates at Folsom Dam would be lowered by 15 feet. Levee, river bank and structural modifications would be the same as in Alternative 1.

200-Year Flood Protection Level

5. Construct upstream flood detention dam. Under this alternative, a 570,000 acre-feet dam and reservoir would be built at the Auburn site. An estimated 540,000 acre-feet would be for active flood control and 30,000 acre-feet for sediment storage. The reservoir would normally be empty and only store water during high-flow conditions. As proposed, this "dry" dam would have an outlet tunnel or gate which would restrict flow to levels that would provide a 200-year level of flood protection without much modification or alteration of downstream flood control structures. This flood control only facility would function much like the cofferdam that existed at the Auburn site until it was washed out by the storm in February 1986.

The area upstream of the detention dam would be flooded with an estimated 5,010 acre-feet (540 feet elevation) of water once every two years; higher flows, creating a pool of 50,780 acre-feet (650 feet elevation), would have a 10 percent chance of occurring every 10 years. Flows creating a pool of 574,780 acre-feet (876 feet elevation) would have a 0.5 percent chance of occurring every 100 years (a 200-year level-of-protection). High flows would occur sporadically during the winter period, and the reservoir would be filled for only a short period of time (1-2 days) following the cessation of rainfall. The reservoir would hold water during the storm, but drainage out of the reservoir would occur simultaneously while it was filling. Therefore, in a storm of a 10-12 day duration, the dam would continue to store water for 1-2 days after the rains stop (11-14 days total) (M. Rice, Corps of Engineers, pers. commun).

6. Construct "small" upstream multipurpose reservoir. This alternative consists of building an 850,000 acre-feet reservoir at the Auburn site. An estimated 600,000 acre-feet would be for flood control storage and 30,000 acre-feet for sediment storage. The flood control storage in Folsom Reservoir would be reduced to 300,000 acre-feet.

7. Construct "large" upstream multipurpose reservoir. Under this alternative, a 2.3 million acre-feet reservoir would be constructed at the

Auburn site. This facility would include 620,000 acre-feet of flood control storage and 30,000 acre-feet for sediment storage. The flood control space at Folsom Reservoir would be reduced to 300,000 acre-feet.

Natomas Area Alternatives

Various flood control measures were combined into three alternatives for the Natomas area. With modifications, the three alternatives can provide either a 100-year or a 200-year level of flood protection.

100-Year Flood Protection Level

1. Construct levees with gated structure and pumping station at Natomas Cross Canal. This alternative consists of raising levees and constructing new levees along the Natomas East Main Drainage Canal, Dry Creek, Arcade Creek, Sacramento River, and Yolo Bypass. A gated embankment structure would be constructed at the mouth of the Natomas Cross Canal, and a 2,500 cfs pump station would be installed. Several bridges would be raised or replaced, and about 20,000 lineal feet of riprap would be installed on the Sacramento Bypass. The apron at Sacramento Weir would be extended.
2. Construct cross levee at Del Paso Road. Under this alternative, a new levee ranging in height from 20 to 25 feet would be constructed adjacent to Del Paso Road. In addition, the construction measures under the previous alternative would be the same, except for the exclusion of (1) the gated embankment and pump at the Natomas Cross Canal, (2) raising or replacing the Highway 99 bridge, and (3) raising the levee along the Sacramento River.
3. Construct cross levee at Elverta Road. Under this alternative, a cross levee would be constructed adjacent to Elverta Road combined with the same levee and structural modifications as the Del Paso Road cross levee.

200-Year Flood Protection Level

Combined measures from the previous three alternatives with modifications can provide a 200-year level of protection. In general, levee work would be more extensive, pumps would have larger capacities, bridges would be raised higher, and the apron at Sacramento Weir would be larger.

Combination of Alternatives

The alternatives for the American River and Natomas areas can be combined into plans to reduce potential flooding throughout the watershed. The details of possible combinations of alternatives will be included in the Corps' forthcoming Reconnaissance Report (U.S. Corps of Engineers 1987).

EXISTING RESOURCES

Lower American River

Aquatic Resources

The lower American River represents a significant biological, economic, and recreational resource to California. One of every six salmon landed in California ocean commercial and sport fisheries is produced in the American River. An estimated 552,000 fishing visits were projected for the river in 1985, and 958,000 fishing visits are projected for 2020. The economic value in direct revenues of the chinook salmon resource of the lower American River has been estimated at \$9.3 million annually. The annual market value of sport fishing for lower American River fish is estimated at \$6.4 to \$7.4 million, and the non-market value is estimated at \$24.7 to \$32.3 million (California State Water Resources Control Board 1987).

At least 41 different species of fish are known to occur in the lower American River, and nine of these species are anadromous. Higher than natural summer flow releases from Folsom Reservoir probably contribute to the number and abundance of fish species in the river. The most important fish species from an economic and recreational perspective are chinook salmon, steelhead trout, striped bass, and American shad. More information is available on chinook salmon than the other species, and most people agree that it is the most important fish species in the river (California State Water Resources Control Board 1987).

Adult fall-run chinook salmon spawn in the lower American River beginning in mid-October and continuing into January. Most natural spawning occurs between Ancil Hoffman Park and Nimbus Dam, with about 75 percent occurring near Sailor Bar. The remaining spawners are trapped and spawned at the Nimbus Salmon and Steelhead Hatchery. It is estimated that natural production in the lower American River combined with hatchery production from Nimbus Salmon and Steelhead Hatchery annually contributes about 190,000 salmon of harvestable size to the fishery, with over 50,000 spawners returning to the river and hatchery. Previously depressed chinook salmon runs in the lower American River have increased since construction of Folsom Dam and Nimbus Salmon and Steelhead Hatchery in 1955 (U.S. Fish and Wildlife Service 1984, California State Water Resources Control Board 1987). A small run of adult chinook, probably strays from other rivers, also enters the river during the late spring and early summer; these fish are also pursued by anglers, particularly just downstream of Nimbus Dam.

American shad were introduced into the Sacramento River system from the East Coast in the early 1870's, and now support a popular sport fishery in the lower American River (California State Water Resources Control Board 1987). The American shad population in the lower American River has been estimated as high as 500,000 fish (U.S. Fish and Wildlife Service 1986). Based on limited available data, it has been hypothesized that the number of shad spawning in the American River is influenced primarily by the ratio of flow in the American River to flow in the Sacramento River (Painter et

al. 1978). The higher the ratio of American River flows to Sacramento River flows, the larger the shad run (Kelly et al. 1985). Shad typically enter the river during their annual spawning migration from about May through early July. The lower American River is known only as a spawning area for shad, as the newly spawned, semi-buoyant eggs typically drift with the current into the Sacramento River before hatching. Juveniles are then reared in the Sacramento River or Delta (California State Water Resources Control Board 1987).

The steelhead run in the lower American River averages about 20,000 fish. About 95 percent of this run is hatchery supported due to high mortality on the natural population from lethal water temperatures (primarily during summer-through fall), predation, and angler harvest. Steelhead return to the river to spawn roughly from August through February (U.S. Fish and Wildlife Service 1984).

Striped bass occur in moderate numbers during most months of the year, but tend to be most abundant from about April through October. No significant spawning is believed to occur, but this has never been adequately studied. However, an immigration of striped bass occurs during the spring, coinciding with spring spawning runs of stripers up the Sacramento River (U.S. Fish and Wildlife Service 1986).

Other common game fish species in the lower American River system include rainbow trout, smallmouth bass, largemouth bass, white crappie, bluegill, and catfish. Common nongame species include carp, Sacramento squawfish, Sacramento sucker, hardhead, and tule perch.

Fish species found in Folsom Reservoir include rainbow and brown trout, largemouth and smallmouth bass, black and brown bullhead, white and channel catfish, green and redear sunfish, and bluegill. The sport fishery is primarily for largemouth and smallmouth bass, rainbow and brown trout, kokanee salmon, and sunfish. Kokanee salmon are a lake-locked race of sockeye salmon commonly stocked in large reservoirs. The Department of Fish and Game has also occasionally stocked excess chinook salmon fry which have later contributed to angler bags.

Rainbow trout, kokanee salmon, and white sturgeon were planted in Folsom Reservoir in 1964 to develop a two-story fishery. This fishery plan has met with only limited success. The factors limiting fish production in the lake are believed to be the natural low productivity of the lake and large fluctuations in water level. The fluctuating water levels reduce spawning success of largemouth bass and other sunfish. These factors combined with moderate angler success account for the relatively low angler use of Folsom Reservoir. Angler use is presently estimated at 120,000 days. In contrast, angler use at Lake Natoma, a much smaller reservoir which receives periodic stocking of trout, is estimated at 150,000 days (U.S. Fish and Wildlife Service 1984).

Terrestrial Resources

The 23-mile-long lower American River Parkway has about 3,700 acres of terrestrial vegetation. Approximately 1,230 acres are covered by grasslands and pasture, about 810 acres are riparian woodlands, 1,020 acres are oak woodlands, another 550 acres are composed of mostly scrub-shrub vegetation, and 90 acres are sand and gravel (California State Water Resources Control Board 1987). The river, adjacent backwater areas, and dredger ponds created during the gold rush era create the land-water interface which greatly improves the habitat value of the lower American River.

More than 220 species of birds, 50 species of mammals, and an undetermined but substantial number of reptile and amphibian species inhabit the lower American River ecosystem. The dense, mature riparian and oak forests mixed with open grasslands combined with year-round water create high quality wildlife habitats. The values of these habitats have become even greater because the lower American River is surrounded by urban development.

Characteristic bird species of the riparian and oak forests include red-tailed and red-shouldered hawks, black-shouldered kite, California quail, Nuttall's woodpecker, downy woodpecker, scrub jay, American crow, plain titmouse, house wren, rufous-sided towhee, song sparrow, and house finch. Mammal species common to the riparian and oak forests include black-tailed deer, gray fox, raccoon, Virginia opossum, western gray squirrel, and ringtail.

The grasslands lack the number of wildlife species found in the riparian and oak forests; however, the interspersed of these three habitats improves the habitat value of the grasslands. Raptors and several species of mammals which nest and hide in the surrounding riparian and oak woodlands use grasslands to feed. Characteristic species which favor grassland habitats are the American goldfinch, western meadowlark, California ground squirrel, and gopher snake.

The aquatic habitats important to terrestrial animals include the river, dredger ponds, and backwaters. Wildlife species which use these areas include the great blue heron, green-backed heron, wood duck, mallard, belted kingfisher, beaver, muskrat, river otter, bullfrog, and western pond turtle. The dense riparian vegetation bordering these habitats accentuates their value by providing cover and shade.

Natomas Area

Aquatic Resources

Relatively little information exists on the aquatic resources of the Natomas area. Major water sources include the Natomas Cross Canal, Natomas East Main Drainage Canal, West Canal, and Fisherman's Lake. The Natomas Cross Canal is the migration route of chinook salmon from the Sacramento River to spawning areas in Auburn Ravine and Coon Creek. American River

chinook salmon also use the Natomas East Main Drainage Canal as a migration route to spawn in Dry Creek, Minor and Secret Ravines. The California Department of Fish and Game has been stocking Auburn Ravine and Coon and Dry Creeks for a number of years in an effort to establish a chinook salmon run. The resident fish in these canals probably include catfish, carp, and suckers. Angler-use in these canals is relatively low and is concentrated at bridges crossing the canals which serve as convenient fishing access points.

Terrestrial Resources

The Natomas area is dominated by agriculture, and therefore natural vegetation communities are small and scattered. Riparian vegetation occurs within the channels created by levees of the Natomas Cross Canal, Natomas East Main Drainage Canal, Dry Creek, and Arcade Creek. In addition, several smaller drainage ditches which drain the area support pockets of riparian vegetation. These pockets of riparian vegetation are extremely valuable to wildlife because of the rarity of native habitats in the Natomas area. Many of the same wildlife species which occur in the riparian forests of the lower American River use the pockets of riparian vegetation in the Natomas area.

The agricultural areas flood during the winter and often support large numbers of wintering waterfowl and shorebirds. Species include mallard, northern pintail, American wigeon, American coot, killdeer, western sandpiper, and dowitchers. Raptors such as red-tailed hawks, American kestrels, northern harriers, and black-shouldered kites rely on the open fields to hunt. Great blue herons, great egrets, and snowy egrets feed along the canals and in the fields. Ring-necked pheasant, burrowing owls, western meadowlarks, California ground squirrels, and numerous species of small mammals occur in the pastures in the Natomas area.

Auburn Area

Aquatic Resources

Relatively little information exists on the aquatic resources of the Auburn Reservoir site and the North and Middle Forks of the American River. Rainbow trout, brown trout, and smallmouth bass are found in both forks of the river as well as Lake Clementine. Rainbow trout and possibly kokanee salmon from Folsom Reservoir use both forks of the river for spawning (Gerstung 1971). The North Fork of the American River includes Lake Clementine, formed by the North Fork debris dam, which floods 5 miles of the river. About 5,000 angler-days occur on Lake Clementine, and about 8,000 angler-days occur on river reaches within the Auburn Reservoir site (California Department of Parks and Recreation 1979).

Terrestrial Resources

The Auburn reservoir site is characterized by steep river canyons which are covered by five plant communities including chaparral, foothill woodland,

valley grassland, riparian woodland, and montane coniferous forest (California Department of Parks and Recreation 1979). Valley grasslands are interspersed among the woodland and forest communities, and many islands of grassland are scattered within chaparral. Approximately 50 to 90 percent of the grassland is composed of exotic grasses, including Bromus, Poa, and Hordeum. Chaparral dominates the south and west-facing slopes, and it occurs extensively on dry slopes, ridges, and hillsides. Characteristic chaparral plants are chamise, manzanita, buckbrush, toyon, and yerba santa.

The foothill woodlands are composed of both deciduous and evergreen trees. Interior live oak, blue oak, and digger pine are the dominant species. Riparian woodlands are rather uncommon given the narrow river channel and lack of alluvial floodplain. They occur as corridors of vegetation along the stream and river channels, edges of ponds and marshes, and in seepage areas. Typical riparian species are cottonwood, box elder, willow, and Oregon ash.

Montane coniferous forest is dominated by ponderosa pine, and this community occurs in the moist north and east-facing slopes within the foothill woodlands. Other typical species include Douglas-fir, bigleaf maple, and black oak. Montane coniferous forests become more common in the upper reaches and higher elevations of the project area.

Typical mammal species occurring in the foothill woodlands, montane coniferous forests, valley grasslands, and riparian forests include black-tailed deer, gray fox, western gray squirrel, bobcat, coyote, mountain lion, raccoon, black bear, and striped and spotted skunks. The grasslands support large numbers of rodents which provide the prey base necessary to support many carnivorous mammals, as well as birds of prey. The Iowa Hill winter deer range borders the extreme end of the project area on the North Fork of the American River, and the Foresthill winter deer range borders the extreme end of the project area on the Middle Fork of the American River (California Department of Parks and Recreation 1979).

Woodlands dominated by oaks in California support over 100 species of birds (Verner 1979). Birds typical of the oak-dominated woodlands in the Auburn area include red-tailed and Cooper's hawks, wild turkey, California quail, band-tailed pigeon, acorn woodpecker, scrub jay, plain titmouse, orange-crowned warbler, black-headed grosbeak, rufous-sided towhee, wrentit, bushtit, Hutton's vireo, and California thrasher. Wood ducks are known to nest along the river (California Department of Parks and Recreation 1979).

THREATENED AND ENDANGERED SPECIES

Our previous planning aid letter dated July 20, 1987 and the August 4, 1987 letter from our endangered species staff provided you information on threatened and endangered species in the project area. At this time, we have no new information. Upon completion of the biological assessment, if the Corps finds that a listed species may be affected by the project,

formal consultation will be required under Section 7 of the Endangered Species Act.

FUTURE CONDITIONS WITHOUT THE PROJECT

Lower American River

Aquatic Resources

Under without-project conditions, aquatic resources within the lower American River could decline unless regulatory agencies such as the State Water Resources Control Board limit water diversions to protect aquatic resources. There are increased demands for water from the lower American River by agricultural, municipal, and industrial users. Upstream diversions and changes in the operations at Folsom Reservoir could also result in reductions in instream flows, water quality, and aquatic habitat. At this time, instream flows for the lower American River are required according to Decision D-893 of the California Water Resources Control Board. This decision falls far short of instream flows necessary to maintain existing aquatic resources. The U.S. Fish and Wildlife Service, California Department of Fish and Game, and City and County of Sacramento have all recommended flow rates substantially higher than Decision D-893. Currently, the actual releases from Folsom Reservoir have in most cases exceeded those required by Decision D-893. The following documents list and discuss recommended flows for the lower American River: U.S. Fish and Wildlife Service (1985), California Department of Fish and Game (1986), and California State Water Resources Control Board (1987).

Angling use and waterway recreation will likely increase due to increased population and the associated increasing demand for recreation. The lower American River is unusual because it is a federally-designated Wild and Scenic River flowing through a major urban community. The current estimated 5 million visitor-use days annually exceed levels for Yellowstone or Yosemite National Parks.

Terrestrial Resources

Most lands within the American River Parkway are protected from development. However, there are plans to develop additional recreational facilities at various locations in the Parkway (Sacramento County 1985). Some changes could occur in the riparian community because of future flow reduction due to planned water withdrawals. California Exposition and State Fair is currently reviewing a plan to expand its operations into the Bushy Lake area. Should any of these activities occur, there will be a reduction in the amount of riparian, and grassland habitat along the Parkway.

Natomas Area

Aquatic Resources

Aquatic resources within the Natomas area generally are expected to undergo some decline without a flood control project. Urban growth will likely reduce water quality and habitat. Populations of anadromous fish within Dry Creek may be adversely impacted because of flood control structures that may be constructed near Roseville along Dry Creek. Also, a proposed sewage conveyance alignment may be constructed along Dry Creek, thereby impacting fish populations.

Terrestrial Resources

Terrestrial resources are expected to decline. The North Natomas area is undergoing rapid urban development, and many of the agricultural areas which provide wildlife habitat are now for sale. The flood control and sewer line projects along the Dry Creek could result in losses of riparian vegetation. However, lack of federally approved flood protection for the Natomas area would limit development and lessen impacts to terrestrial resources.

Auburn Area

Aquatic Resources

Without the project, aquatic resources in the Auburn area are expected to decline due to increased agricultural and domestic water user demands unless regulatory agencies such as the State Water Resources Control Board limit water diversions to protect existing aquatic resources. The Bureau of Reclamation intends to restore the Auburn dam site and streambed if their project is deauthorized (U.S. Bureau of Reclamation 1987). Although fish populations may decrease, angling use of the river and Lake Clementine will likely increase with the increase in human population in the Auburn area.

Terrestrial Resources

The existing Auburn damsite will be restored under without-project conditions. With successful restoration, wildlife species displaced by project construction will gradually reinhabit these areas. Interim mitigation is being attempted on 900 acres to compensate for temporary wildlife habitat losses until the disturbed areas have sufficiently recovered. Urban growth occurring in the Auburn area will continue with or without the project. Little or no growth is anticipated within the canyon, and some development is projected for the ridgetops surrounding the canyon.

If the Bureau of Reclamation does not build a multipurpose reservoir at the Auburn site, previously purchased reservoir lands would be transferred to the Federal General Services Administration for disposition. Until the disposition of the 26,230 acres, federal monies would be required to

reimburse local law enforcement and fire protection agencies and the California Department of Parks and Recreation for operating the Auburn State Recreation Area (U.S. Bureau of Reclamation 1987). More recently, Friends of the River has proposed that the reservoir lands be designated as a National Recreation Area and administered by a Federal or State entity (American River Watershed Hearing November 1987).

IMPACTS OF ALTERNATIVES

The degree of impacts to aquatic and terrestrial resources cannot be fully evaluated until more specific and detailed alternatives and site plans are presented. In addition, various alternatives may be combined to form a comprehensive flood control plan. The impacts from a comprehensive flood control plan could be cumulative with a much greater level of impact than that of a single alternative, or they could be less depending on the alternative(s) selected. The following section is a general discussion of the significant impacts anticipated from the individual alternatives based on their descriptions by the Corps of Engineers (1987).

Lower American River

100-year Flood Protection Level

1. Increase lower American River channel capacity and objective release at Folsom. Installation of riprap and levee raising would result in the loss of about 110 acres of riparian vegetation along the lower American River where there is extensive riparian vegetation along the waterline. This acreage figure is approximate and derived assuming a 50 feet wide zone cleared of vegetation for the construction of riprap. There would be losses of heavily-shaded aquatic habitat which is high quality habitat for fish and many aquatic mammals. Heavily-shaded aquatic habitat provides shade which moderates shoreline water temperatures, and provides insect drops which are prey for fish. Impacts would occur to all riparian species, including the federally-listed threatened valley elderberry longhorn beetle and state-listed threatened Swainson's hawk (The Swainson's hawk also is a candidate for federal listing).

The sustained maximum flows which could occur with levee upgrading could have adverse impacts to habitat for riparian terrestrial species, anadromous fish, and other aquatic organisms. The high flows could cause losses of vegetation, bank erosion, and damage to Nimbus Fish Hatchery. With the exception of damage to the fish hatchery, these impacts are part of the natural fluvial process. However, since sustained flows approaching 180,000 cfs would rarely occur on the lower American River, impacts to aquatic and terrestrial habitat by these higher flows are expected to be small.

2. Increase flood control storage and objective release at Folsom and increase lower American River channel capacity. Increasing the flood storage space in Folsom Reservoir to 630,000 acre-feet would have significant adverse impacts to reservoir and downstream fisheries.

Reducing the amount of water in the reservoir would reduce the amount of the food-producing littoral zone thereby reducing both cold water and warm water fish populations. Also, the conservation pool would be reduced which could lessen the amount of water in the reservoir. In addition, available cold water in storage would likely decrease and adversely affect coldwater fish such as rainbow trout and kokanee salmon. Increased temperatures of water released from Folsom Reservoir would adversely affect salmon and steelhead in the lower American River, especially if this warmer water was released when salmon were spawning. The reduced pool in Folsom Reservoir would likely result in a decrease in flows in the lower American River, particularly during the critical fall spawning period. The amount and quality of aquatic habitat in the river would be decreased with reduction in flows.

Less riparian vegetation would be lost due to riprapping under this alternative than under Alternative 1. The amount lost is estimated at over 70 acres assuming a 50 foot wide zone cleared of vegetation. Raising of levees along the American River, Arcade Creek, Natomas East Main Drainage Canal, and the Yolo Bypass would also cause losses of riparian and levee vegetation. If the bridges were reconstructed during the spring and summer when birds such as cliff swallows are nesting, mortality and/or abandonment of nesting would likely occur.

3. Increase flood control storage and lower the spillway at Folsom.

Impacts to reservoir and downstream fisheries caused by increasing the flood control storage would be very similar to those discussed under the previous alternative. Lowering the spillway would have minor impacts if maximum objective releases remain at 115,000 cfs because riprap would not be required for bank stabilization. As presented, it appears that objective releases would remain at 115,000 cfs with this alternative (U.S. Army Corps of Engineers 1987).

150-year

4. Increase flood control storage, increase objective release and lower the spillway at Folsom and increase lower American River channel capacity. Impacts to reservoir and downstream fisheries would be similar to those discussed under the previous two alternatives which proposed 630,000 acre-feet and 650,000 acre-feet flood control storage, respectively. Increasing the channel capacity to 180,000 cfs would entail installation of about 110,000 lineal feet of riprap, and modifications to levees and bridges would be similar to the first 100-year alternative. Therefore, impacts to riparian vegetation, levee vegetation, and aquatic habitat caused by riprap and increased channel capacity would be similar to those discussed for the first 100-year alternative. It is estimated that about 110 acres of riparian vegetation could be lost with the installation of 110,000 lineal feet of riprap.

200-year Flood Protection Level

5. Construct upstream flood detention dam. Primary impacts from a flood storage only facility would be to terrestrial vegetation. The ability of a given plant species to withstand flooding is the result of a complex interaction of changes in soil chemistry caused by flooding, adaptive abilities of the plant to tolerate flooding, and secondary factors such as water depth, temperature, turbidity, and time of year. Therefore, it is extremely difficult to predict the impacts to terrestrial vegetation with intermittent flooding of various depths and durations under this alternative. At this time we can only provide a general discussion of these impacts. More detailed analysis will be necessary.

Deciduous species suffer little stress if inundation occurs during the dormant season when the tree is leafless (Walters et al. 1980). Most of the species in the riparian zone, such as cottonwood and willow, are deciduous, and they are adapted to periodic inundation. Inundation appears to have the greatest impact to vegetation if it occurs during the growing season. During the growing season, box elder, white alder, cottonwood, and willow are classified as very tolerant to inundation for periods as long as two or more growing seasons. Oregon ash is classified as tolerant with the ability to withstand inundation for at most one growing season. Valley oak, bigleaf maple, ponderosa pine, Douglas-fir, California laurel, and redbud are considered intermediately tolerant and can survive inundation for one to three months during the growing season (Walters et al. 1980a and 1980b). Harris et al. (1969) found that interior live oak did not survive partial inundation for seven days during the growing season.

Based on these studies, it would appear that many of the dominant plants of the riparian forest, valley woodland, and montane coniferous forest can withstand inundation for as long as one month during both the dormant and growing season. However, the ability of plants to withstand flooding, decreases with increases in the frequency of inundation. Therefore, vegetation in the lower elevations which could be subjected to more frequent inundation may suffer higher rates of mortality than vegetation at higher elevations.

Information on the inundation tolerance of chaparral and grassland vegetation (A. Leiser, Univ. of California, Davis, pers. commun.) is scant. However, Whitlow and Harris (1979) report that some grass species including Poa will not survive long periods of inundation. At this time, we cannot be sure of the ability of chaparral and grassland vegetation to withstand intermittent inundation. It appears that the chaparral vegetation behind the cofferdam in the Auburn reservoir area has not suffered high loss during past high water periods. Much of the grassland habitat is at the higher elevations where inundation would rarely occur. Further study is needed to fully address this impact.

Impacts to wildlife from intermittent inundation are likely to be minor if the existing vegetation communities are not damaged. Larger, more mobile animals such as black-tailed deer, gray fox, bobcat, raccoon, and coyote

should be able to escape from the rising waters because they are active during the winter. However, losses could occur of bear and western gray squirrel which are inactive during very cold periods during the winter. Losses are very likely of small mammals, reptiles, amphibians and smaller animals which are limited in their ability to escape rapidly rising water levels.

Under this alternative, impacts to aquatic resources should be relatively minor. In fact there may be some potential benefits as the intensity of high flows is reduced. Proper sizing of the detention dam outlet to enable adequate discharge to carry new gravels and flush existing river beds is needed. There should be less scouring of the riverbed as water velocity will be reduced as it backs up under high flow conditions. There may be some reduction in fish mortality due to reduced scour of redds and reduced involuntary transport of juveniles. About 34 miles of river canyon would be inundated when the reservoir was full at 570,000 acre-feet. At full capacity, water would inundate Lake Clementine, causing some damage to sport fishing facilities.

6. Construct "small" upstream multipurpose reservoir. Constructing of the multipurpose reservoir would permanently inundate 39 miles of river and 5,300 acres of land (U.S. Bureau of Reclamation 1987). A high quality stream fishery for rainbow and brown trout and smallmouth bass providing approximately 20,000 angler-days annual use would be lost. An additional 19,000 angler-days of quality reservoir fishing at Lake Clementine also would be lost. The impact of a multipurpose reservoir on downstream fisheries of the lower American River is dependent on the reservoir's operation. If the multipurpose reservoir is operated to optimize fishery management, some benefits to downstream fisheries could be achieved. Water from the reservoir could be used to moderate flows and temperatures in the lower American River. Water levels in Folsom Reservoir could be stabilized by a multipurpose facility by reducing the flood storage space at Folsom to 300,000 acre-feet. Production of bass and sunfish in Folsom Reservoir would increase with stabilized water levels in April and May (U.S. Fish and Wildlife Service 1984). However, if the multipurpose reservoir is not managed to optimize the fisheries, then the end result would be the loss of 39 miles of river including Lake Clementine, and replacement with a low production reservoir fishery and a reduced anadromous fishery in the lower American River.

The permanent inundation of over 5,300 acres of habitat would adversely impact wildlife. Substantial losses will occur for all wildlife species including important game animals such as black-tailed deer, mountain and California quail, wild turkey, and western gray squirrel. Habitat losses will impact all resident and migratory wildlife dependent on lands inundated by the reservoir. With adequate and successful mitigation through intensive management of adjacent areas, losses of black-tailed deer habitat can be recovered through controlled burning of chaparral vegetation and other methods of habitat improvement (U.S. Fish and Wildlife Service 1976). However, a Habitat Evaluation Procedures (HEP) Study is needed to quantify losses of habitat as well as mitigation requirements.

7. Construct "large" upstream multipurpose reservoir. The 2.3 million acre-feet reservoir would inundate an estimated 48 miles of river and 10,000 acres of land (U.S. Bureau of Reclamation 1987). Impacts to fishery resources would be similar to but greater than those estimated under the previous alternative. Reducing the flood control space in Folsom Reservoir to 300,000 acre-feet would help stabilize fluctuating water levels, thereby providing some fishery benefits. However, the improvements in the Folsom Reservoir fishery, and the development of the Auburn Reservoir fishery would not provide in-kind replacement for the loss of 48 miles of river fishery upstream of the Auburn damsite. Topography at the Auburn site, expected water level fluctuation, and water quality within the reservoir will result in a relatively unproductive fishery with limited recreational opportunity due to low fishing success and lack of easy access.

Impacts to wildlife would be much greater than those under the previous alternative. We previously estimated that habitat for approximately 1,000 black-tailed deer would be lost (U.S. Fish and Wildlife Service 197). This estimate must be refined with future studies, and a HEP is necessary to assess the value of the reservoir area to black-tailed deer.

Natomas Area

100-year Flood Protection Level

1. Construct levees with gated structure and pumping station at Natomas Cross Canal. Many of the impacts from this alternative would be from constructing new levees and raising existing levees. Riparian vegetation is growing within the Natomas East Main Drainage Canal and along Dry and Arcade Creeks. It appears likely that some riparian vegetation would be removed with the levee work. Natomas East Main Drainage Canal has several areas of older riparian vegetation within the flood channel bounded by the levees. Dry Creek and the Natomas Cross Canal also have notable amounts of riparian vegetation in the proposed work areas. There are elderberry plants along the Natomas Cross Canal which support valley elderberry longhorn beetles. The state-listed threatened giant garter snake, a candidate for listing by the U.S. Fish and Wildlife Service (Hansen 1986) occurs in wetlands and drainage canals in the Natomas area. Any loss of riparian vegetation in the Natomas area is significant because urban and agricultural practices have already substantially reduced the amount of wildlife habitat. The riparian vegetation in the canals represents some of the best quality riparian habitat remaining in the Natomas area.

Potential impacts to fish would be primarily due to restricted access of fish movement into and out of the gated structure at the entrance of the Natomas Cross Canal and the Sacramento River. Some fish losses would likely occur during pumping operations. However, these losses are expected to be minor because anadromous fish spawning movements occur in the fall when the gate and pump would likely not be operating. If bridge reconstruction occurs during the breeding season, birds such as cliff swallows which nest under and on the bridges could be impacted. Raising

levees on the Yolo Bypass and riprapping both sides of the Sacramento Bypass could result in losses of grassland habitat which support small mammal populations and provides nesting habitat to waterfowl and ring-necked pheasant.

Providing flood control in this area will also result in secondary impacts such as increased rate of land conversion from agricultural use to municipal, industrial and residential use. This will bring about a gradual loss of seasonal wetlands which provide important over-wintering habitat for many migratory and shorebirds.

2. Construct cross levee at Del Paso Road. This alternative is very similar to the previous alternative; impacts would therefore be similar. Construction of the cross levee would result in the loss of agricultural lands, riparian vegetation, and wetlands. The Del Paso Road levee would intersect Fisherman's Lake which is part of the West Drainage Canal. Raptors, waterbirds, and other species dependent on the riparian vegetation and impounded water in Fisherman's Lake would lose some habitat. The gated structure at the Natomas Cross Canal, raising or replacing the Highway 99 bridge, and raising the levee along the Sacramento River would be excluded from this alternative. Limiting flooding in this area would adversely impact water-dependent birds which utilize the seasonally flooded lands in the Natomas area by reducing the areal extent of flooded areas.

3. Constructing cross levee at Elverta Road. This alternative would be the same as the previous alternative, except that the cross levee would be built adjacent to Elverta Road. Impacts similar to the previous alternative are thus expected, but a much greater area would be protected from flooding. The cross levee would bisect a wetland area with surrounding riparian vegetation just north of the Sacramento Municipal Airport. This cross levee would limit flooding in a much greater area than the Del Paso Road cross levee, thereby further reducing the amount of seasonally flooded area available to water-dependent birds.

200-year Flood Protection Level

To accomplish a 200-year level of protection, the components of the three previous Natomas area alternatives would be combined and expanded, with more extensive levee work, and higher bridges; also the apron at Sacramento Weir would be larger. Losses of riparian vegetation, wetlands and agricultural lands due to construction would be proportionately greater than the previous three alternatives. Impacts to fish because of increasing pump capacity likely would be greater than under the 100-year level-of-protection alternative.

Our previous planning aid letter (dated July 20, 1987) discussed the Service's mitigation goals for various habitats impacted by the project alternatives and the technical rationale behind these goals. Although some changes in the alternatives have been made by the Corps, it was not necessary to change the mitigation goals and compensation recommendations

for this planning aid letter. The following discussion is supplemental to our previous letter.

The lower American River from its mouth at the Sacramento River upstream to Nimbus Dam has significant biological, economic, recreational, and scenic values. This reach of the lower American River is part of the National Wild and Scenic Rivers System, and the river was so designated because of its unique recreational value and outstanding anadromous fishery resource, primarily chinook salmon. The value of the lower American River to fisheries and wildlife is accentuated by its extensive riparian forests.

The chinook salmon was selected at the evaluation species for aquatic habitat in the lower American River. The lower American River is unique because it is a major chinook salmon spawning area amidst a major urban center. Both spawning and rearing habitat are of high value to chinook salmon, and it is not feasible to replace losses of this habitat. Our mitigation goal for spawning and rearing habitat is no loss of existing habitat value.

Riparian forests in the lower American River are important to a large number of resident and migratory birds. In addition, within the American River Parkway, riparian forests contribute substantially to the value of the surrounding terrestrial and aquatic habitats. Riparian vegetation bordering the river supplies insect drops for fish and helps to moderate the aquatic temperatures. These riparian forests provide habitat for several rare and endangered species. Our mitigation goal for all riparian vegetation along the lower American River is also no loss of existing habitat value.

Oak woodland and grassland habitats along the lower American River are high value habitats to the evaluation species which are migratory birds. These habitats are scarce within the American River Parkway and difficult to replace. Riparian and wetland habitat in the Natomas area and the Auburn site are also of high value to the evaluation species. Evaluation species chosen for riparian habitat in the Natomas area are raptors and migratory birds, and wetland evaluation species at Natomas and Auburn are migratory waterfowl and shorebirds. Evaluation species for riparian habitat at the Auburn site are passerine birds. Our mitigation goal for all of these habitats is no net loss of in-kind habitat value. Losses of habitat value can be compensated through enhancement or creation of similar habitat values.

Chaparral, valley woodland, and montane coniferous woodland habitats at the Auburn site are high to medium habitat value to game birds such as California quail and band-tailed pigeons, and black-tailed deer. Within the area, these habitats are still relatively abundant. However, habitat losses of these habitats are occurring at a rapid rate in the Sierra foothills, and valley woodland and montane coniferous woodland habitats are becoming less abundant. Our mitigation goal is for no net loss of habitat value while minimizing loss of in-kind habitat value.

ACCEPTABILITY OF THE ALTERNATIVES FROM A FISH AND WILDLIFE PERSPECTIVE

To maintain and, if possible, enhance the unique and valuable fish, wildlife (including endangered species), and recreational resources that exist in the project areas, we recommend that a flood control alternative or set of alternatives be selected that (1) will avoid adverse effects on the aquatic and riparian habitats on the lower American River and (2) greatly minimizes and mitigates for the unavoidable impacts on aquatic, riparian and other habitat types throughout the remainder of the lower American River and Natomas areas.

For evaluation purposes, we have ranked each flood control alternative according to their acceptability from a fish and wildlife perspective. Acceptability in this sense suggests avoiding or minimizing the impacts to fish and wildlife resources and the ability to successfully mitigate unavoidable impacts on the site. Each alternative was evaluated independently based on these criteria: (1) impacts to threatened and endangered species; (2) impacts to anadromous fish; (3) scarcity and irreplaceability of habitats impacted; (4) overall habitat value to wildlife; (5) overall habitat value to resident fish; and (6) total losses of wildlife and fish habitat. It is important to keep in mind that we were unable to provide any combined alternative assessment, and it appears likely that an alternative(s) for the lower American River will be combined with an alternative(s) for the Natomas area to develop a comprehensive regional flood control project. Cumulative impacts of combined alternatives may be much greater than that anticipated by our assessments, and the environmental acceptability of any combined plan of individual alternatives likely would be reduced.

In this analysis, we assessed all alternatives equally regardless of the level of flood protection each provided. The Service is not making any recommendations concerning what is an adequate level of flood protection; these alternatives were evaluated solely from the perspective of impacts to fish and wildlife resources. In the absence of additional information, this evaluation uses the "worst case" scenario. That is, multipurpose reservoirs were assumed not to include benefits to fishery resources, levees are assumed to be constructed across riparian and wetland areas, and levees are assumed to be raised on their waterside. These evaluations will be reanalyzed when additional information becomes available and specific plans are presented.

A high level of acceptability rating should not be interpreted to mean that the Service is not concerned about the impacts of that alternative. All alternatives appear to have significant impacts to fish and wildlife resources; however, given the current available knowledge, and the limited time available to write this letter, alternatives that have a relatively high acceptability appear to have less impacts.

Lower American River

Of the seven alternatives presented for the lower American River area, the flood detention facility at the Auburn site is the most acceptable alternative because of the relatively minor impacts to fish and wildlife resources. Minor impacts are anticipated for resident and anadromous fish in the watershed, and no endangered species are known to occur in the project area. Much of the vegetation possibly affected by temporary inundation has some degree of flood tolerance which will reduce flood-induced mortality. However, much information needs to be gathered on tolerance in chaparral and grassland habitats, as well as threatened and endangered species in the area.

The second highest ranked alternative in acceptability is to increase flood control storage at Folsom and lowering the spillway at Folsom. Both Folsom reservoir fisheries and downstream fisheries would suffer some adverse impacts from the alternative. However, there would be relatively minor impacts to downstream riparian habitats and endangered species.

The remaining alternatives differed very little in their overall impacts, and each would have extensive adverse impacts and therefore would not be acceptable to the Service. The reduced environmental acceptability for the alternatives involving riprapping the lower American River are primarily due to the impacts to riparian habitat which support the valley elderberry longhorn beetle and Swainson's hawk. Impacts to anadromous fish, primarily chinook salmon and resident fish, were responsible for the reduced environmental acceptability for alternatives involving increasing flood control storage at Folsom Reservoir and constructing a multipurpose facility at Auburn. The lack of endangered species in the Folsom and Auburn areas reduced their impacts somewhat, but a more thorough survey of endangered species is needed.

Based on the acceptability ranking, it is unlikely that the Service can fully support any of the alternatives except for the upstream flood detention only. Increasing flood control storage at Folsom Reservoir to 650,000 acre-feet and lowering the spillways at Folsom Dam by 15 feet would cause significant impacts to the Folsom reservoir fishery. The multipurpose reservoirs, increasing objective channel releases to above 130,000 cfs, and increasing channel capacity all include measures harmful to fish and wildlife. The alternatives involving riprapping the lower American River would likely adversely impact the valley elderberry longhorn beetle and Swainson's hawk. Increasing flood control storage at Folsom Reservoir and constructing the multipurpose reservoirs would adversely impact resident and anadromous fish and possibly the lower American River riparian community.

Natomas Area

The alternative with the highest acceptability from a fish and wildlife perspective for the Natomas area is the Cross Levee at Del Paso Road. Some losses would occur to riparian vegetation, and potential impacts to the

valley elderberry longhorn beetle, Swainson's hawk, and giant garter snake are of concern. The other alternatives will result in significant losses of wildlife habitat and likely prompt rapid development of the Natomas area.

Summary

Based on our preliminary analysis, we have serious concerns about all alternatives for flood control in the American River area. However, the alternative with the least impact is the flood detention dam at the Auburn site. The Service feels that this flood detention dam should not be convertible into a multipurpose reservoir which would result in future adverse impacts. The Corps should include detailed analysis of the impacts to fish and wildlife and benefits with this alternative in their feasibility studies. A cross levee at Del Paso Road appears to be the most environmentally suitable alternative for flood control in the Natomas area.

Mitigation Recommendations

We recommend that project alternatives be designed from the outset to avoid and/or minimize adverse impacts to fish and wildlife. Plans should be developed to mitigate unavoidable impacts. A detailed analysis of impacts and mitigation will be provided in our detailed report required under Section 2 of the Fish and Wildlife Coordination Act. The following are some general guidelines to minimize impacts of proposed alternatives to fish and wildlife.

Planned use of existing upstream reservoir space for partial flood control represents one potential mitigation measure.

Levee improvements should be conducted on the landside of the existing levees thereby avoiding damage to riparian vegetation, particularly along the lower American River. It will be very difficult to replace 70-110 acres of riparian vegetation. Avoiding any losses of riparian vegetation is a desired mitigation strategy. Channelization and bank stabilization work should not be conducted, or it should be minimized. However, impacts to oak woodlands and grasslands within the lower American River may be offset by acquiring lands suitable for revegetation and natural succession.

At the Auburn site, in order to minimize impacts to terrestrial and aquatic resources, water should be impounded for flood control purposes for as short a period of time as possible. Additional information is required to assess the effects of stabilized water levels in Folsom, controlling high flows in the area above Auburn and within the lower American River, and inundation on plant communities, particularly chaparral, grassland, and montane coniferous forests. Until that information is gathered and analyzed, mitigation recommendations for fisheries impacts and vegetation losses must be considered preliminary for project planning. Mitigation for ongoing impacts at the Auburn site is in progress on 900 acres, and provisions to fulfill responsibility for this mitigation must be made if a flood control facility is built at the site.

Impacts to riparian habitat along the Natomas Cross Canal and East Main Drainage Canal, as well as Dry and Arcade Creeks could be minimized by doing levee work on the landside of the levee. Unavoidable losses to riparian vegetation could be mitigated through a number of means. Suitable replacement lands could be purchased and revegetated. Also, appropriate habitat management of the Natomas East Main Drainage Canal could improve the existing riparian habitat. The value of the habitat within the canal is severely degraded because of unauthorized garbage dumping and vehicular traffic. The water in the canal appears to be polluted by upstream sources. Limiting vehicle access and garbage dumping combined with a habitat management plan could accomplish much in the way of improving the habitat value of the Natomas East Main Drainage Canal. Fencing the levee and gating roads along the canal would be a first step in improving habitat.

Cross levees in the Natomas area could be planned to minimize loss of riparian and wetland areas. In addition, the existing drainage patterns could be utilized to continue flooding of seasonal wetlands and canals that provide valuable wildlife habitat. Replacement lands could be purchased and managed to replace lost habitat values.

Endangered species such as the valley elderberry longhorn beetle, Swainson's hawk, and giant garter snake would benefit from improvements in existing riparian habitats. Planting elderberry bushes could be done at revegetation areas, and existing stands of mature riparian vegetation suitable for use by Swainson's hawks could be protected. Riparian stands could be developed to provide replacement habitat for Swainson's hawks as existing nesting areas are lost due to development or natural decay. The habitat value of drainage canals and wetlands in the Natomas area to the giant garter snake could be increased by habitat improvement and limiting human disturbance, particularly along the Natomas East Main Drainage Canal and Cross Canal.

FISH AND WILDLIFE INFORMATION NEEDS

There is a lack of information on fish and wildlife resources for the entire American River watershed. The comprehensive nature of the proposed flood control projects necessitates impact assessment studies of similar extent. No comprehensive, systematic inventory of the terrestrial resources exists for the lower American River, Auburn area, or Natomas area. There is limited information on the quantity and quality of both terrestrial and aquatic habitats along the lower American River and within the Auburn and Natomas areas.

There is presently insufficient data for assessing impacts on chinook salmon, spawning gravel, striped bass, and American shad in the lower American River. Current information on the status of Folsom Reservoir and Lake Clementine fisheries and the river fishery above Auburn damsite is needed. Surveys for valley elderberry longhorn beetle are needed from Auburn to Nimbus Dam, as well as the Natomas area.

Based on these information needs, we recommend that a number of studies be conducted. The types of studies needed and level of effort are dependent on the level of flood protection and alternative selected to reach that level of flood protection. Selection of an alternative that provides a higher level of flood protection does not necessarily equate to a greater study effort and cost. The cost and manpower estimates of these recommended studies are preliminary and subject to revision based on refinement in the flood control alternatives and availability of new information.

In the following list we have identified the studies needed, effort, and agency suited for the work for each level of protection in each area.

Lower American River Area

100-Year Flood Protection Level

(1) Increase Lower American River Channel Capacity and Objective Release at Folsom

Fisheries

STUDY TASK	AGENCY	\$ COST
A. Spawning gravel mapping survey on the Lower American River	FWS	30,000
B. Bedload transport and gravel recruitment study	Corps	
C. Fisheries riprap impact analysis	FWS	8,000

Wildlife

STUDY TASK	AGENCY	\$ COST
A. Terrestrial Habitat Evaluation Procedures along the American River	FWS	34,850

(2) Increase Flood Control Storage and Objective Release at Folsom and Increase Lower American River Channel Capacity

Fisheries

STUDY TASK	AGENCY	\$ COST
A. Spawning gravel mapping survey on the Lower American River	FWS	30,000
B. Bedload transport and gravel recruitment study	Corps	
C. Fisheries riprap impact analysis	FWS	8,000

D. Fisheries impact operations analysis on flood control storage	FWS & Corps	8,200
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Wildlife

STUDY TASK	AGENCY	\$ COST
A. Terrestrial Habitat Evaluation Procedures along the American River	FWS	34,850
B. Review and summarize studies of wildlife response to reservoir level fluctuations	FWS	8,200
C. Review and summarize studies of riparian vegetation response to flow modifications	FWS	9,900

(3) Increase Flood Control Storage and Lower Spillway at Folsom

Fisheries

STUDY TASK	AGENCY	\$ COST
A. Fisheries impact operations analysis on flood control storage	FWS & Corps	8,200

Wildlife

STUDY TASK	AGENCY	\$ COST
A. Review and summarize studies of wildlife response to reservoir level fluctuations	FWS	8,200
B. Review and summarize studies of riparian vegetation response to flow modifications	FWS	9,900

150-year Flood Protection Level

(4) Increase Flow Control Storage and Objective Release and Lower Spillway
at Folsom and Increase Lower American River Channel Capacity

Fishery and Wildlife

Studies needed would be the same as those required (2) above for the 100-year level where increased flood control storage, increased objective release and increased channel capacity are included.

200-Year (or greater) Flood Protection Level

(5) Construct New Upstream Flood Detention Dam

Fisheries

STUDY TASK	AGENCY	\$ COST
A. Aquatic habitat mapping of inundation area	FWS	29,930
B. Fish population survey	FWS	31,160
C. Angler use survey	FWS	37,720
D. Low level aerial mapping of inundation area	Corps	

Wildlife

STUDY TASK	AGENCY	\$ COST
A. Terrestrial Habitat Evaluation Procedures in the Auburn Reservoir area	FWS	43,050
B. Survey of terrestrial vegetation in the Auburn Reservoir area to determine impacts to vegetation caused by flooding	FWS	22,550
C. Review and summarize studies of wildlife response to periodic flooding	FWS	8,200

(6) Construct New Upstream Multi-Purpose Reservoir (Small)

Fisheries

STUDY TASK	AGENCY	\$ COST
A. Aquatic habitat mapping of inundation area	FWS	29,930
B. Fish population survey	FWS	31,160
C. Angler use survey	FWS	37,720
D. Low level aerial mapping of inundation area	Corps	
E. Fisheries impact operation analysis on flood control at Folsom	FWS & Corps	8,200

Wildlife

STUDY TASK	AGENCY	\$ COST
A. Terrestrial Habitat Evaluation Procedures in the Auburn Reservoir area	FWS	43,050

B. Review and summarize studies of wildlife response to periodic flooding FWS 8.200

- (7) Construct New Upstream Multi-Purpose Reservoir (Large)
 Fisheries and wildlife studies needed would be similar to the smaller multi-purpose reservoir alternative above.

Natomas Area

100-Year Flood Protection Level

- (1) Construct Levees with Gated Structures and Pumping Station at Natomas Cross Canal
 Fisheries

No new fisheries data needs to be collected for this alternative.

Wildlife

STUDY TASK	AGENCY	\$ COST
A. Terrestrial Habitat Evaluation Procedures for the Natomas Area	FWS	22,550
B. Survey of valley elderberry longhorn beetle habitat in the Natomas Area	FWS or Consultant	10,250
C. Assess secondary impacts from flood protection on seasonal wetlands in Natomas Area	FWS	2,050

- (2) Construct Cross Levee at Del Paso Road

Fisheries

There would not be any need for additional fisheries studies with this alternative.

Wildlife

STUDY TASK	AGENCY	\$ COST
A. Terrestrial Habitat Evaluation Procedures for the Natomas Area	FWS	22,550
B. Survey of valley elderberry longhorn beetle habitat in the Natomas Area	FWS or Consultant	10,250
C. Assess secondary impacts from flood protection on seasonal wetlands in Natomas Area	FWS	2,050

(3) Construct Cross Levee at Elverta Road

Fisheries

There would not be any need for additional fisheries studies with this alternative.

Wildlife

STUDY TASK	AGENCY	\$ COST
A. Terrestrial Habitat Evaluation Procedures for the Natomas Area	FWS	22,550
B. Survey of valley elderberry longhorn beetle habitat in the Natomas Area	FWS or Consultant	10,250
C. Assess secondary impacts from flood protection on seasonal wetlands in Natomas Area	FWS	2,050

200-Year Flood Protection Level

(4) Construct Levees with Gated Structure and Pumping Station at Natomas Cross Canal

Fisheries - No new fisheries data needs to be collected for this alternative.

Wildlife - Wildlife studies needed would be the same as in (1) above.

(5) Construct Cross Levee at Del Paso Road

Fisheries - Fisheries studies needed would be the same as in (2) above.

Wildlife - Wildlife studies needed would be the same as in (2) above.

(6) Construct Cross Levee at Elverta Road

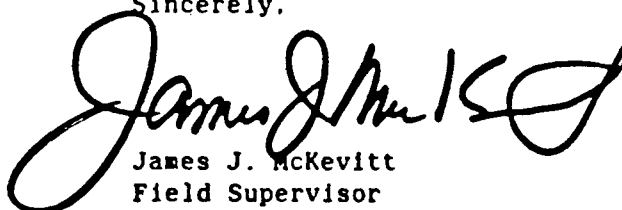
Fisheries - Fisheries studies needed would be the same as in (1) above.

Wildlife - Wildlife studies needed would be the same as in (1) above.

An extensive survey of valley elderberry longhorn beetle habitat is needed for the area along the American River from Auburn to Nimbus Dam. This study was not itemized under a specific alternative for the lower American River because we were not sure which alternative would most likely impact beetle habitat in this area. Likely alternatives are those proposed for Folsom Reservoir. We estimate that this survey would cost \$20,500 and it could be conducted by the Service or a qualified consultant.

We appreciate the opportunity to provide input to your planning process.
Please contact Barry Garrison or Gary Taylor (916-978-4613) if you require assistance.

Sincerely,



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